

From THE DEPARTMENT OF DENTAL MEDICINE
Karolinska Institutet, Stockholm, Sweden

**TOOTH LOSS AND PROSTHETIC REPLACEMENTS
AMONG PERSONS WITH DEPENDENCY AND
FUNCTIONAL LIMITATIONS**

Angelika Lantto



**Karolinska
Institutet**

Stockholm 2018

All previously published papers were reproduced with permission from the publisher.

Published by Karolinska Institutet.

Printed by E-print AB 2018

© Angelika Lantto, 2018

ISBN 978-91-7676-913-3

Tooth Loss and Prosthetic Replacements among Persons with Dependency and Functional Limitations

THESIS FOR DOCTORAL DEGREE (Ph.D.)

By

Angelika Lantto

Principal Supervisor:

Associate Professor Inger Wårdh
Karolinska Institutet
Department of Dental Medicine
Section of Oral Diagnostics and Surgery

Co-supervisors:

Professor Mats Trulsson
Karolinska Institutet
Head of Department of Dental Medicine

Professor Karin Zingmark
Luleå University of Technology
Department of Health Sciences
Division of Nursing Care

Opponent:

Professor Gunhild Vesterhus Strand
University of Bergen
Department of Clinical Dentistry

Examination Board:

Associate Professor Dorota Religa
Karolinska Institutet
Department of Neurobiology, Care and Society
Division of Clinical Geriatrics

Associate Professor Annsofi Johannsen
Karolinska Institutet
Department of Dental Medicine
Division of Oral Diseases

Associate Professor Katharina Wretling
Malmö University
Department of Odontology

To

Lars

Cornelia, Agnes

and

in memory of Ruth and Karl

‘When I got teeth I could really chew my food ...and since then I feel like my whole body is different.’

‘Teeth are so...you know; dental care is the most important aspect of healthcare.’

‘So let’s say you meet somebody, and then you want to kiss that person but...you just think the whole time, what if it is obvious I have false teeth?...’

Quotes from study participants in the thesis

ABSTRACT

The overall aim of this thesis was to obtain a decision basis for assessments and planning regarding prosthetic treatments for persons with dependency and functional limitations. For this purpose the epidemiology of tooth loss and prosthetic replacements was mapped out, and the patient perspective was reflected in studies performed in Norrbotten County, the northernmost part of Sweden. As a reference for study design, data from an epidemiologic survey of oral health among the general population in the same geographical region, EPI-Norr, was used. The study populations were sampled from the register of the increased financial support system in Norrbotten County and included *a. Elderly in nursing homes*, *b. Persons with certain functional impairments (covered by the Act Concerning Support and Service, LSS)*, *c. Home-care patients with dependency and functional limitations*, and *d. Independent persons with long-lasting functional limitations with extensive need for dental care due to illness that causes functional impairments*. The results from the study populations were compared with results from matched controls sampled from the register of dental records in the Public Dental Service in Norrbotten County in Study I and with data from the EPI-Norr study in Study II.

The first three studies were observational cross-sectional studies with data collection from dental records in Study I, by clinical examinations in Study II and by questionnaires in Study III.

In Study I, the prevalence of tooth loss and performed prosthetic treatments was compared with results from matched controls representing the general population. In Study II, oral status and prosthetic replacements were described, and prosthetic treatment needs were defined and compared with results from a general population. The results showed that the study population had fewer teeth, a higher proportion of complete tooth loss, more dentures and fewer tooth- and implant-supported prostheses compared with the control groups from the general population. In Study II, 42% of the dentures in the upper jaw and 51% in the lower jaw were in poor condition. The study population had fewer occlusal posterior contacts compared with the control population in all ages. Elderly in nursing homes had the lowest number of teeth and highest proportion of complete tooth loss, but all categories had fewer teeth compared with the control populations of the same ages.

The study subjects in Study II who were able to answer questions in a questionnaire were invited to participate in Study III, in which possible associations between tooth loss, prosthetic replacements, oral health-related quality of life (OHRQoL) and health-related quality of life (HRQoL) were examined. The aim was also to study if the chosen quality of life instruments GOHAI, OHIP-14 and RAND-36 were appropriate to use in the actual population. The results showed weak associations between clinical variables and the results of the questionnaires, which indicates that it may not be appropriate to use common OHRQoL instruments in populations with care-dependency. Elderly in nursing homes had the poorest oral status among the different categories, yet they reported the best QoL. The

majority in this category thought that they could manage with the current situation after they lost teeth but half of them reported that they could not eat all kinds of foods.

Study IV was a qualitative interview study aimed at exploring the experience of receiving and living with dental implants among persons with functional limitations. 17 patients with several types of functional impairment who had undergone treatment with dental implants were interviewed. Analysis of the open-ended questions began at the first interview and proceeded concurrently until no further relevant information could be obtained. In the results, 'The implant treatment is a process of normalization' was identified as the core category. It was related to four other categories: 'The functionally impaired are also entitled to dental care', 'Edentulousness is a burden for functionally impaired individuals', 'There is interaction between implant treatment and other aspects of life' and 'It is important to understand the implications of implant treatment'.

The conclusion of the thesis is that despite the favourable conditions in Sweden for oral healthcare of persons with dependency and functional limitations, there are great differences in tooth loss and how tooth loss is treated compared with a general population. There are more dentures and fewer tooth and implant-supported prostheses among these persons even if interviews show that some of them can benefit from treatment with dental implants. However, this is difficult to confirm through validated oral health-related quality of life instruments. This vulnerable population does not often actively demand dental and oral care, and thus their needs have to be identified in other ways and by other professionals than dental healthcare services.

LIST OF SCIENTIFIC PAPERS

- I. **Lantto A**, Lundqvist R, Wårdh I.
Tooth Loss and Prosthetic Treatment in Dependent and Functionally Impaired Individuals with Respect to Age and Gender.
Int J Prosthodont. 2016; 29(1): 68-70
- II. **Lantto A**, Lundqvist R, Wårdh I.
Oral Status and Prosthetic Treatment Needs in Functionally Impaired and Elderly Individuals.
Int J Prosthodont. 2017 Nov 22. [Epub ahead of print].
- III. **Lantto A**, Lundqvist R, Wårdh I.
Quality of Life in Relation to Tooth Loss and Prosthetic Replacements Among Persons with Dependency and Functional Limitations.
In manuscript
- IV. **Lantto A**, Wårdh I.
Dental implants in the functionally impaired: experience from the patients' perspective.
Acta Odontol Scand. 2013; 71(3-4): 525-33.

CONTENTS

1	Introduction	1
2	Background.....	3
2.1	Health.....	3
2.2	Oral health	3
2.2.1	Tooth Loss	4
2.2.2	Prosthetic replacements.....	5
2.3	Assessments of Health	5
2.3.1	Health-related quality of life, HRQoL.....	5
2.3.2	Oral health-related quality of life, OHRQoL	5
2.3.3	The experience of health	6
2.4	Dependency and Functional Limitations	6
2.4.1	Functional limitations.....	6
2.4.2	Dependency	7
2.5	The Swedish context	7
2.5.1	The Swedish National Dental Service Act	7
2.5.2	The Dental Services Ordinance (SFS 1998:1338, in Swedish) financial support system regulations	8
2.5.3	Act Concerning Support and Service for Persons with Certain Functional Impairments (LSS)	9
2.5.4	The Swedish Social Service Act.....	9
2.6	Rationale	9
3	Aims.....	11
4	Material and methods	13
4.1	Study design	13
4.1.1	Cross-sectional observational studies	13
4.1.2	Qualitative individual interview studies	13
4.2	Study settings.....	15
4.3	Data Sources	15
4.3.1	The VAS patient register in Norrbotten County	15
4.3.2	The register of increased financial support for dental care	16
4.4	Study populations	16
4.5	Control populations	17
4.5.1	The EPI-Norr study	18
4.6	Sampling	18
4.7	Procedures.....	22
4.7.1	Inclusion criteria.....	22
4.7.2	Exclusion criteria.....	22
4.7.3	Assessment of ability to complete questionnaires.....	22
4.7.4	Advocacy.....	22
4.7.5	Instruments	23
4.7.6	Study variables	24

4.8	Missing data.....	25
4.9	Statistical methods.....	26
5	Results	27
5.1	Results of the study population in total	27
5.1.1	The participants	27
5.1.2	Tooth loss and prosthetic replacements.....	29
5.1.3	OHRQoL and HRQoL	32
5.1.4	Supplementary questions regarding prosthetic replacements	32
5.1.5	Experience of receiving and living with dental implants.....	34
5.2	Results of the categories in the study population	35
5.2.1	Elderly in nursing homes	35
5.2.2	Persons with Certain Functional Impairments	35
5.2.3	Home-care patients with dependency and functional limitations.....	36
5.2.4	Independent persons with long-lasting functional limitations with extensive need for dental care due to illness that causes functional impairments	36
6	Discussion.....	38
6.1	General discussion.....	38
6.1.1	Tooth loss in the general population.....	38
6.1.2	Tooth loss in the study population.....	38
6.1.3	Consequences of tooth loss.....	39
6.1.4	The financial support system	40
6.1.5	Prosthetic replacements	41
6.1.6	Treatment needs	42
6.1.7	QoL.....	42
6.2	Methodological considerations	43
6.2.1	Study design	43
6.2.2	Study population	44
6.2.3	Internal validity	45
6.2.4	External validity	45
6.3	Ethical considerations	46
6.4	Implications	46
6.4.1	Clinical implications	46
6.4.2	Implications for nursing care	46
6.4.3	Implications for future research.....	47
7	Conclusions	48
8	Summary in swedish	49
9	Acknowledgments.....	51
10	References	53

LIST OF ABBREVIATIONS

FDI	World Dental Federation
GOHAI	General Oral Health Assessment Index
GT	Grounded theory
HRQoL	Health-related Quality of Life
ICF	The International Classification of Function, Disability and Health
LSS	Lagen om stöd och service (Act Concerning Support and Service for Persons with Certain Functional Impairments)
OHIP-14	Oral Health Impact Profile, Short version
OHRQoL	Oral Health-related Quality of Life
QoL	Quality of life
RCT	Randomized controlled trial
SPMSQ	Short Portable Mental Status Questionnaire
SPSS	Statistical Package for the Social Sciences
VAS	Vårdadministrativt system (Healthcare Administrative System)
WHO	The World Health Organization

1 INTRODUCTION

It is known that tooth loss has negative consequences for people of all ages, with impact on health and quality of life (1-13). For this reason, knowledge on the prevalence of tooth loss is important. Information on the prevalence can provide a clue to how the resources of the dental care services should be used in a population and it makes the clinician aware of common disorders (14). For the general population, the prevalence of tooth loss is known in Sweden and in many countries (15-20), but the prevalence is not equally well mapped for persons with dependency and functional limitations. However, reports from different groups of people with different types of functional impairments around the world have shown higher prevalence compared with a general population (21-30).

Treatment of tooth loss can be important for the individual and lead to a rehabilitation of function, self-esteem and quality of life (3, 4, 6, 31). The options for treatment are either dentures or different kinds of fixed prostheses. Dentures can be produced at a low cost and without much effort from the patient (32). However, as dentures are not adherent to the jaws, they can be difficult to use (33). Fixed prostheses can make it easier for the patient to eat and speak but the treatment procedure for these replacements can be demanding for the patient (34). Additionally, fixed prostheses are often more difficult to clean compared with dentures.

Many factors are taken into account in assessments of prosthetic treatment needs, such as the clinical situation, the patient's demands, and the ability of the patient to manage dental hygiene and economy. These evaluations are sometimes complicated. When it comes to the treatment of persons with dependency, the assessments can be even more complex (34, 35). It may be difficult to communicate, to obtain informed consent, and the patient may have functional limitations that interfere with the therapy, for example impairments in oral motor function and brain function which are important factors for adaptation to dentures (33, 36).

The Swedish dental care system is purposed for the whole population on equal terms (37). A special financial support system enables dental care for persons with dependency and functional limitations (38). However, there are still indications of unmet prosthetic treatment needs in this group. More knowledge is needed regarding prevalence of tooth loss, how tooth loss has been treated, clinical status of prosthetic replacements, and patient perspective in this population.

2 BACKGROUND

Studies on persons with dependency and functional limitations are difficult to perform. There may be difficulties obtaining informed consent from the participants, the subjects may have trouble understanding and participating in the data collection, and the available instruments may not be developed for this population (39-41). To gain knowledge about this group of people, it is important to find methods which make it possible to include them in studies. First of all, it may be difficult to find a study population which is representative. In Sweden, the population of persons with dependency and functional limitations is defined in the regulations for the financial support system for dental care (38). Those who are covered by the system are recorded in a register at the County Councils. The laws for dental healthcare and social service are important for how the oral health for these people is cared for (37, 42).

2.1 HEALTH

Oral conditions, including tooth loss, are associated to general health (5, 7, 10-13, 43-56). However, health can be defined in different ways. Some advocate a bio-mechanical model, and this view dominated for a long period of time (57, 58). During the twentieth century, other aspects of health were raised and in 1948 the World Health Organization (WHO) defined health as ‘complete physical, mental and social wellbeing, not merely negatively as the absence of disease or infirmity’ (59). The WHO still retains this definition. Since the WHO definition was adopted, more attention has been directed at psychosocial aspects of health such as quality of life and individuals’ own experience of their health. Efforts have also been made to describe and measure health and body functions based on a biopsychosocial view of health.

2.2 ORAL HEALTH

Oral health is an important aspect of health and like the health concept, oral health has also been defined differently. The dental profession adhered to a strictly clinical view of oral health until the late twentieth century. In 1988, a conceptual framework involving socio-medical and biophysical issues was presented by Locker (60).

In 2016 (61), a new definition of oral health was adopted by the World Dental Federation, FDI, which states:

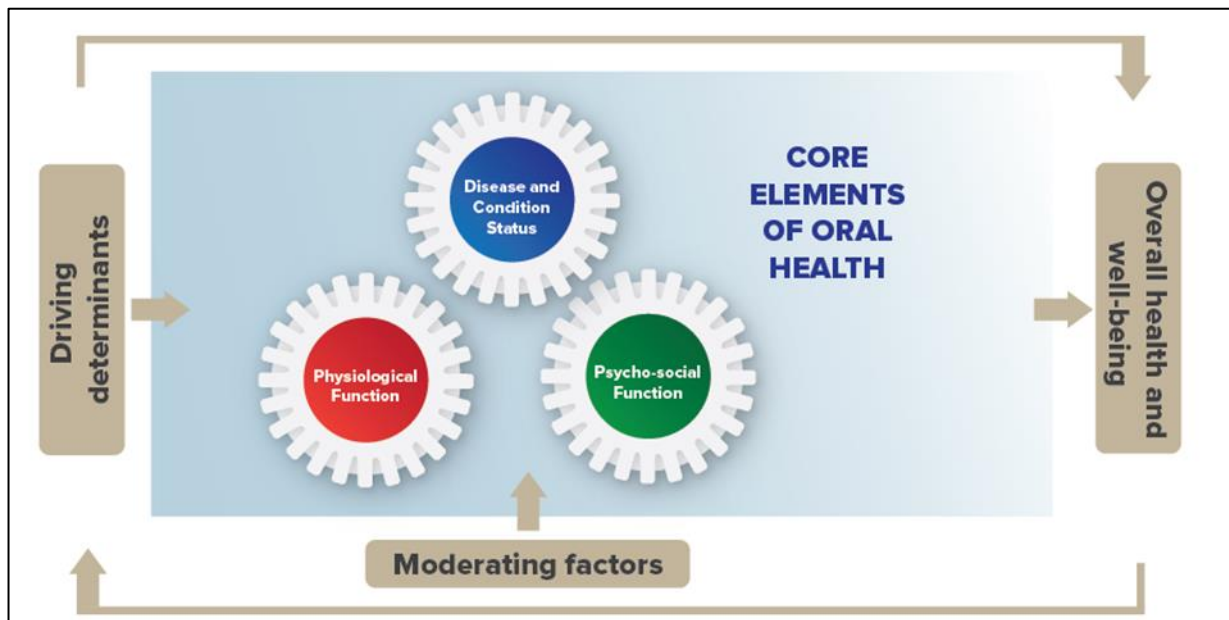
‘Oral health is multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex.

Further attributes related to the definition state that oral health:

- *is a fundamental component of health and physical and mental well-being. It exists along a continuum influenced by the values and attitudes of individuals and communities;*
- *reflects the physiological, social and psychological attributes that are essential to the quality of life;*

- *is influenced by the individual's changing experiences, perceptions, expectations and ability to adapt to circumstances.*

A framework was developed along with the definition, which can be seen in Figure 1.



©FDI World Dental Federation

Figure 1: Framework for the Oral Health Definition according to FDI 2016 (62).

2.2.1 Tooth Loss

Tooth loss can be regarded as the accumulated result of dental disease and can be associated to all core elements of oral health as described by the FDI framework (61, 62). Results of studies have shown associations to self-esteem, social status and function, and have provided evidence of how tooth loss has restricted participation in different life situations (3, 4, 6). Other studies have reported associations between tooth loss and general health such as cognition (13, 54, 55, 63-65), cardio-vascular diseases (11, 12, 51) and mortality (7, 10).

A positive development in oral health has resulted in a decrease of tooth loss both in Sweden and globally (15, 16, 18, 19, 29, 35). However, there are differences in prevalence of tooth loss both between different countries and between different populations in the countries, which can be attributed to socio-economic, cultural and behavioural factors as well as to general health status (20, 22-27, 35, 66-69). A general trend is that tooth loss occurs later in life (18, 20, 35, 70).

2.2.2 Prosthetic replacements

Lost teeth can be replaced by dental prostheses. It has been shown that treatment with dental prostheses can restore function and quality of life in the general population (4, 6, 71-75). Different prosthetic replacements can be used for oral rehabilitation; they can be fixed or removable.

Removable dental prostheses are:

- Complete dentures
- Overdentures retained by teeth or implants
- Removable partial dentures

Fixed dental prostheses are:

- Tooth-supported prostheses
- Implant-supported prostheses

2.3 ASSESSMENTS OF HEALTH

If health is defined by a multifaceted biopsychosocial concept, it has to be described with both clinical parameters and the patients' subjective concerns regarding their health. Clinical variables relevant for this thesis are, for example, number of teeth and type of prosthetic replacements. For measuring patients' subjective concerns regarding their health, specific instruments have been developed. These are referred to as measures of quality of life, QoL, and are important supplements to traditional physiological or biological measures of health status (39, 76, 77).

2.3.1 Health-related quality of life, HRQoL

The term health-related quality of life, HRQoL, is used in relation to general health conditions. Instruments measuring HRQoL show how health impacts an individual's ability to function and his or her perceived wellbeing in physical, mental and social domains of life (78). Measures of HRQoL are used as an outcome in research and it has been shown that these outcome measures are responsive to important clinical changes (76).

HRQoL instruments can be disease-targeted or generic (77, 78). Disease-targeted instruments are relevant to a particular disease. Generic instruments can be profile or preference-based. Profile-based instruments measure multiple aspects of HRQoL and preference-based instruments measure a single summary score that cuts across the multiple domains of HRQoL (78).

2.3.2 Oral health-related quality of life, OHRQoL

Oral health-related quality of life, OHRQoL, is used in relation to oral conditions (79, 80). Several instruments have been designed to measure OHRQoL (39).

2.3.3 The experience of health

Individuals' experience of health cannot be captured by prefabricated instruments (81). An experience is individual and must be explained by the actual person. Through individual qualitative interviews, these experiences can be obtained and analysed (82-84).

2.4 DEPENDENCY AND FUNCTIONAL LIMITATIONS

Several descriptions of functional limitations and dependency have been used historically and are used today. Many descriptions are focused on the 'consequences of disease'. This thesis adheres to the definitions in the International Classification of Functioning, Disability and Health, ICF (85). ICF is a 'components of health' classification. Through the ICF framework, the study population in this thesis is possible to identify not only in Sweden, but also internationally.

2.4.1 Functional limitations

The international standard to describe and measure health and disability is the WHO framework, the International Classification of Functioning, Disability and Health (ICF) (85). It is used at individual and population levels. ICF takes a neutral stand on aetiology. Diagnoses are not in main focus for ICF.

By shifting the focus from health condition to functioning, it places all health conditions on an equal footing, allowing them to be compared using a common metric. Further, it clarifies that we cannot infer participation in everyday life from diagnosis alone.

According to ICF, Functioning and Disability are divided into

- Body Function and Structures
- Activities and Participation

Body functions are the physiological functions of body systems, including psychological function. Body structures are anatomical parts of the body. Impairments are problems in body function or structure. It is important to note that 'impairments are not the same as the underlying pathology, but are the manifestations of that pathology' (85).

Activity is described as the execution of a task or action by an individual. Participation refers to involvement in a life situation. Functioning is an umbrella term for all body functions, activities and participation. Disability is an umbrella term for impairments, activity limitations or participation restriction. There are also environmental factors listed in ICF. A person's functioning and disability is understood as an interaction between health conditions and personal and environmental factors, which is illustrated in Figure 2.

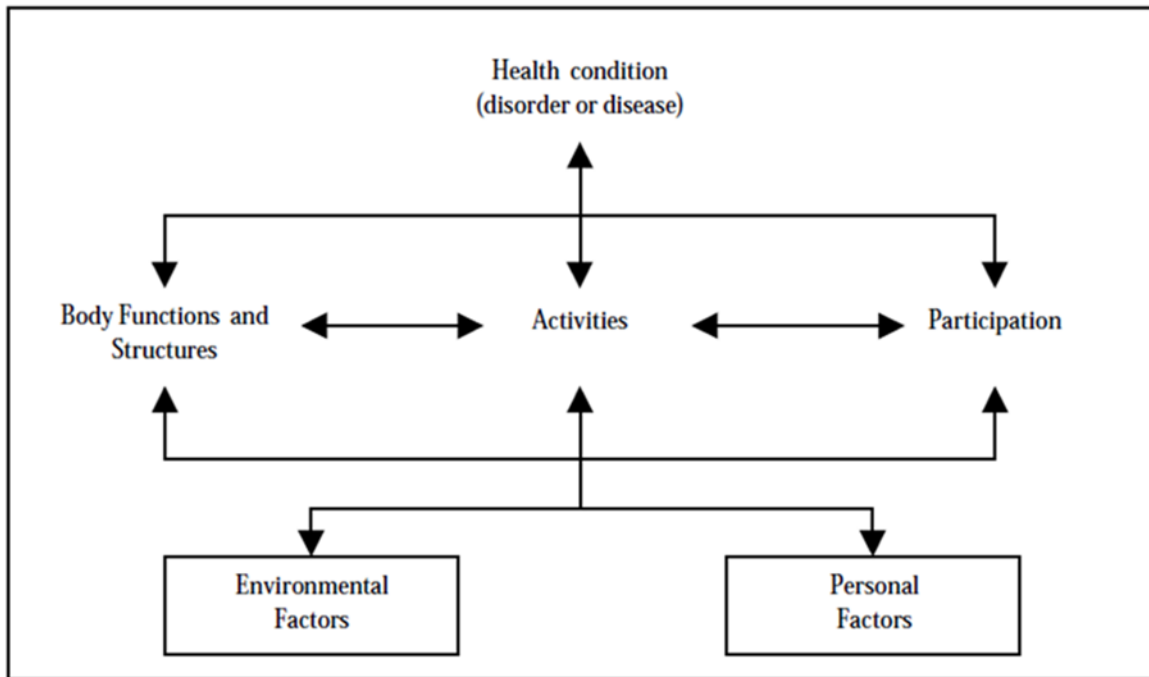


Figure 2. Interactions between the components of ICF (85). Published with permission from WHO.

2.4.2 Dependency

According to ICF, impairments can lead to problems participating and performing different kinds of activities. When a person has severe difficulties performing many activities including activities for self-care, he or she will be dependent on care from others. The implications for oral healthcare are that the ability to manage oral hygiene routines may be declined and in some cases there may also be an influence on activities concerning eating habits. These individuals will be at risk for developing oral disease. Problems in body function, both physical and those involving brain functions, may lead to restrictions in participation, which may result in difficulties undergoing dental treatment.

2.5 THE SWEDISH CONTEXT

In the Swedish context, the population of persons with dependency and functional limitations is defined in the regulations in the increased financial support system for dental care, and the dental care for this population is regulated in the Swedish National Dental Service Act (37, 38). One of the groups included in the increased financial support system is persons with ‘Certain Functional Impairments’ and they are defined in the Act Concerning Support and Service (86). The Social Service Act (42) is important for how the oral health of persons with dependency is cared for in nursing homes and group housings.

2.5.1 The Swedish National Dental Service Act

The Swedish National Dental Service Act (87) regulates interventions for preventing, investigating and treating diseases and injuries in the oral cavity. The objective for dental care

is good dental health and dental care on equal terms for the whole population. The demands on the organization are that dental care shall be of good quality with a good hygienic standard and pay particular attention to preventive measures in order to satisfy the patient's need of safety in the treatment situation, to be available, to be based on respect for the patient's autonomy and integrity, and to promote good contact with the dental care personnel. Acute treatment needs shall be prioritized.

The county council is responsible for planning dental care based on the needs in the population. Sufficient resources have to be available for persons with special needs. These persons are persons with functional limitations who are covered by the Act Concerning Support and Service (86), have long-lasting care-dependency, or have extensive dental treatment needs as a consequence of long-lasting disease or functional impairment.

2.5.2 The Dental Services Ordinance (SFS 1998:1338, in Swedish) financial support system regulations

The dental care regulations for patients with special needs define the persons who are covered by the system and what kind of dental care they are entitled to (38). The regulations differ concerning dental care for persons with long-lasting dependency and functional limitations and dental care for independent persons with extensive dental treatment needs as a consequence of long-lasting disease or functional limitation.

Dental care for persons with long-lasting dependency and functional limitations:

The regulations for persons with dependency and functional limitations include an outreach programme and dental care at a reduced cost. The outreach programme includes an assessment of the need for help with oral hygiene and a preliminary assessment of the need for 'substantial dental care'. The assessment shall be based on the ability of the individual or the care personnel to perform oral hygiene.

The assessment of need for 'substantial dental care' shall be based on the general state of health of the individual. 'Substantial dental care' is defined as dental care which substantially improves the ability to eat and speak. In the choice between different treatment options, the most cost-effective treatment is included. Fixed prosthetic replacements behind the premolars are not included. If the general state of health of the patient inhibits more extensive treatment, the focus should be on preventing pain and discomfort.

Dental care for independent persons with extensive dental treatment needs as a consequence of long-lasting disease or functional limitation:

The regulations for independent persons with long-lasting functional limitations and with extensive need for dental care due to functional impairment or long-lasting illness include dental care at a low cost. Treatments with fixed prosthetic replacements are not included.

2.5.3 Act Concerning Support and Service for Persons with Certain Functional Impairments (LSS)

The Act Concerning Support and Service for Persons with Certain Functional Impairments (LSS) (86) regulates measures for special support and special service for those

1. *‘who are mentally retarded, are autistic or have a condition resembling autism,*
2. *who have a considerable and permanent, intellectual functional impairment after brain damage when an adult, the impairment being caused by external force or a physical illness, or*
3. *who have some other lasting physical or mental functional impairments which are manifestly not due to normal aging, if these impairments are major ones and cause considerable difficulties in daily life and, consequently, an extensive need for support and service.’*

2.5.4 The Swedish Social Service Act

The Social Service Act regulates social service and healthcare provided by the municipality (42). The social service shall be based on democracy and solidarity and promote people's economic and social security, equality in living conditions and active participation in society. The social service shall, with respect to people's responsibility for their own and others' social situation, focus on liberating and developing individuals' and groups' own resources. The activities shall be based on respect for human autonomy and integrity.

2.6 RATIONALE

In view of a biopsychosocial model of oral health, tooth loss has severe implications on an individual's health and wellbeing. The consequences of tooth loss among persons with dependency and functional limitation are not fully known. Previous research on persons with dependency and functional limitations has basically dealt with the situation in groups with specified diagnoses or functional impairments. This has been important for the understanding of the chosen groups, but it has been difficult to get an overall view of the oral health and treatment needs among persons with special needs. The new approach in this thesis is that the study population is chosen based on the levels of dependency and functional limitations. It makes it possible to discover what is common for these people, which in turn is important for planning dental care on a population level.

There are special challenges connected with oral healthcare for the actual population. The interface between the dental healthcare services and the nursing care system is one area. Another area is how different financial support systems have an impact on what kind of care will be offered. An additional challenge is how to measure the patient perspective, as many of the individuals in the group have communication problems. How do we know what kind of care will benefit the patients best?

3 AIMS

The general aim of this thesis was to obtain a decision basis for assessments and planning regarding prosthetic treatments for persons with dependency and functional limitations.

The specific aims were

- | | |
|-----------|---|
| Study I | To compare the prevalence of tooth loss and performed prosthetic treatments among persons with dependency and functional limitations with that of general population. |
| Study II | To describe oral status and prosthetic replacements, and to define prosthetic treatment needs among persons with dependency and functional limitations in comparison with a general population. |
| Study III | To examine possible relations between tooth loss, prosthetic replacements, oral health-related quality of life, OHRQoL and health-related quality of life, HRQoL, among persons with dependency and functional limitations. The aim was also to study if the chosen quality of life instruments were appropriate for the actual population. |
| Study IV | To explore the experience of receiving and living with dental implants among persons with functional limitations. |

4 MATERIAL AND METHODS

4.1 STUDY DESIGN

To address complex problems in healthcare research, a mixed methods approach can be effective (88). Quantitative and qualitative methods can be used together in order to capture different perspectives. In this thesis, we used quantitative and qualitative methods in separate studies for the general aim; see Table 1.

Study I and Study II were quantitative studies aimed at mapping out the epidemiology of tooth loss and prosthetic replacements in the study population compared with a general population. The difference between the studies was that Study I used data collected from patients who had a dental examination documented in their dental record and Study II included persons who both did and did not have regular dental care. For this reason, the subjects in Study I could be assumed to be healthier than those in Study II. Another difference was that the control group in Study I was sampled at the same time as the study group and was matched with respect to age and sex, while in Study II the control was made by comparisons with another study, EPI-Norr (19), from the same geographical region performed four years earlier. The age structure was not the same in the study material in Study II and the control. Comparing the results from Study I and Study II enabled a more complete picture of the focus population. The results from Study I were important in order to estimate the sample size of Study II.

Study III and Study IV were intended to capture the patient perspective. The difference between these studies was that Study III had a quantitative approach and used validated quality of life instruments while Study IV was a qualitative interview study.

4.1.1 Cross-sectional observational studies

Studies I, II and III were cross-sectional observational studies; see Table 1. In a cross-sectional study, a research field is observed at a specified time and conclusions can be drawn according to the present status in a study group (14). It is not possible to make conclusions about causality from studies of this design.

4.1.2 Qualitative individual interview studies

One of the methods in qualitative research is the individual interview model (82-84), which was used in Study IV. Interviews give in-depth information about participants' experiences and viewpoints on a topic.

The method used for the interview study was inspired by grounded theory (GT), a methodology developed in the social sciences (89-93). The result is inductively derived from systematically collected and analysed data. It can be hypothesis-generating and is reliable for the study population. It cannot be directly transferred to other contexts.

The interview was semi-structured and had a conversational style with open-ended questions based on an interview guide; see Table 2. The process proceeded until theoretical saturation was achieved, i.e. until new information was not found by more data collection (90-93).

Table 1. Overview of the included studies in the thesis.

	Study I	Study II	Study III	Study IV
Design	Observational cross-sectional	Observational cross-sectional	Observational cross-sectional	Qualitative, Interview Study
Population	<i>Study group:</i> Persons with dependency and functional limitations <i>Control:</i> The general population in the same geographical area	<i>Study group:</i> Persons with dependency and functional limitations <i>Control:</i> The general population in the same geographical area	<i>Study group:</i> Persons with dependency and functional limitations	<i>Study group:</i> Persons with dependency and functional limitations
Number	<i>Study group:</i> 225 <i>Control group:</i> 228	<i>Study group:</i> 355 <i>Control group:</i> 908	<i>Study group:</i> 180	<i>Study group:</i> 17
Data sources	<i>Study group:</i> Dental records at the Public Dental Health Service <i>Control group:</i> Dental records at the Public Dental Health Service	<i>Study group:</i> Clinical examinations <i>Control:</i> The EPI-Norr study	<i>Study group:</i> Questionnaires and clinical data from Study II	<i>Study group:</i> Interviews
Time of data collection	2013 collection of data from records no more than 3 years old	2015	2015	2010-2011
Outcome	Prevalence of tooth loss and prosthetic replacements	Prevalence of tooth loss, prosthetic replacements and treatment needs	OHRQoL HRQoL	Categories in an explanation model

Table 2. Study IV. Issues in the interview guide.

Issues
Experience of tooth loss
Initiative to implant treatment
Expectations ahead of treatment
Experience of the treatment process
Reception of staff
Information from staff
Function, aesthetics, phonetics
Social aspects
Quality of life
General health
Hygiene

4.2 STUDY SETTINGS

In the studies in this thesis, we used data collected from dental records (Study I), clinical examinations (Study II), questionnaires (Study III) and interviews (Study IV) in all municipalities, urban and rural areas in Norrbotten County, the northernmost part of Sweden. The examinations and interviews took place in dental clinics near the homes of the participants or in their own homes; see Table 1.

4.3 DATA SOURCES

4.3.1 The VAS patient register in Norrbotten County

We used records of the Public Dental Health Service and the Department of Oral Surgery at Sunderby Hospital for data collection in Study I; see Table 1. Dental and medical records in Norrbotten County Council are administered in a digital system, the VAS patient register (Vårdadministrativt system) (94, 95).

4.3.2 The register of increased financial support for dental care

In Study I and Study II, we used the register of increased financial support for dental care according to SFS 1998:1338 (38) for sampling to the study groups. The persons who are entitled to the financial support system are recorded in the register at the county council. In Norrbotten County, around 7000 individuals are registered. Both those who are receiving regular dental care and those who are not are included in the register (Table 1).

4.4 STUDY POPULATIONS

The study populations in this thesis included persons with functional limitations living in nursing homes, group housings or own homes. The characteristics of the study population were that they had physical, mental or psychiatric impairments which were congenital, acquired or as part of ageing. The special diagnoses were not important for this thesis. Instead, the focus was on how functional impairments influence oral status according to the definitions in the ICF (85).

In Studies I, II and III, the study groups were divided into the same categories as in the increased financial support system for dental care (38) in order to be able to separate subjects with different functional impairments from each other; see Figure 3. However, in the financial support system there is an additional category. As this category included only a few persons and they had the same characteristics as elderly in nursing homes, we merged these two categories into the one we have named category *a*. The subjects were recruited in all ages between 20 and 101. However, the age and sex distributions varied between the studies.

The categories were

- a. Elderly in nursing homes*
- b. Persons with certain functional impairments, which applies to people who have intellectual disabilities, autism or a condition resembling autism, considerable and permanent mental impairment, some other lasting physical or mental impairment that is clearly not due to normal aging, and who have an extensive need for help in daily life as a result of these disabilities (86)*
- c. Home-care patients with dependency and functional limitations*
- d. Independent persons with long-lasting functional limitations with extensive need for dental care due to illness that causes functional impairments*

In this thesis, the majority of the subjects in category *c* were persons with psychiatric diseases.

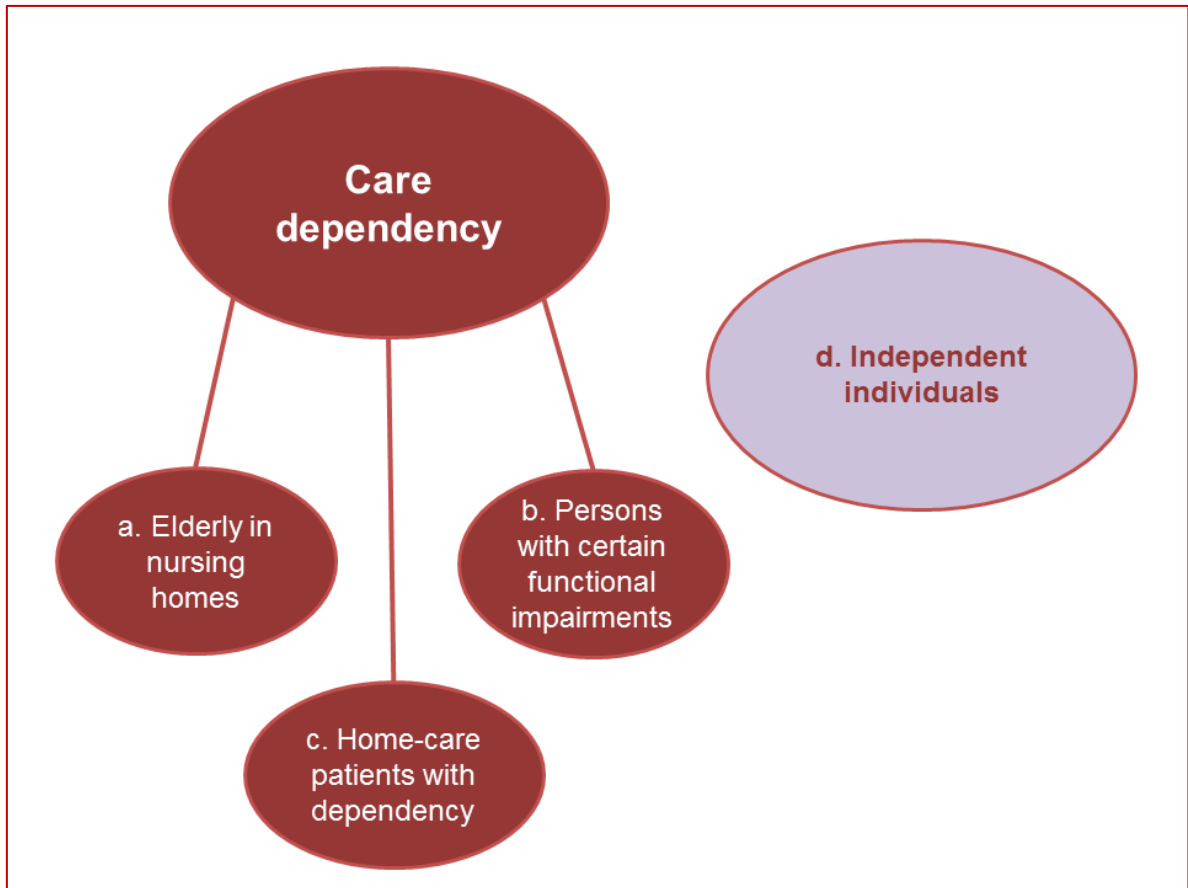


Figure 3. The categories in the study population

Category *d* was not introduced in the financial support system at the time when Study I and Study IV were performed. This category differs from the others with respect of care-dependency. The included are persons who have severe difficulties in performing oral hygiene, severe difficulties taking part in dental care, or orofacial symptoms due to severe psychiatric diseases, Parkinson's disease, multiple sclerosis, cerebral palsy, rheumatoid arthritis, systemic lupus erythematosus, scleroderma, amyotrophic lateral sclerosis, orofacial disability, or remaining symptoms six months after myocardial infarction or stroke.

In Study II, the participants in the study group were divided into age groups intended to match the ages in the EPI-Norr study as closely as possible in order to enable comparisons.

The majority of the participants in Study IV were entitled to the financial support system. However, some of them were either persons who would have belonged to category *d* or were independent, very old home-living individuals.

4.5 CONTROL POPULATIONS

The control populations in this thesis were chosen in order to represent the general population.

In Study I, the control population was sampled from the register of dental records in the Public Dental Health Service in Norrbotten County. As the majority of the population in Norrbotten County at the time for the study used the Public Dental Health Service as their care provider, the register could be regarded as representative of the general population. In Study II, the EPI-Norr study (19) was used as control population.

4.5.1 The EPI-Norr study

In Study II, comparisons were made with the results of the EPI-Norr study (19), which is an epidemiologic cross-sectional survey of oral health based on a questionnaire and clinical examinations of subjects representing the general population randomly sampled from all individuals in the ages 35, 50, 65, 75 and 80 from the civil register in Norrbotten County in 1991, 2001 and 2011. We used the results from 2011.

In 2011, the sampled population included 13,146 individuals. 1400 were selected. 1078 subjects participated in either the questionnaire survey or the clinical study. 1064 subjects completed the questionnaire and clinical data from 908 subjects were collected.

The reasons for not participating in the EPI-Norr study were that the subject was not available at the address (n=45), was sick or had died (n=12), did not show up at the appointment (n=19) and did not want to participate (n=243). The majority of drop-outs were among the 80-year-olds.

Subjects with all sorts of backgrounds, as well as some subjects with dependency and functional limitations, from both urban and rural areas in all municipalities in the county were included.

The questionnaire dealt with personal data, general and oral health, and attitudes to oral health and dental care. The following were recorded in the clinical examination: number of teeth, prosthetic replacements, caries, marginal and apical periodontitis, malocclusions, TMJ dysfunctions, problems with the third molar, disorders in the oral mucosa and treatment needs.

4.6 SAMPLING

In Study I, a stratified proportional random sample was drawn from the register of increased financial dental support in Norrbotten County (38) based on age and sex. Strata for age were defined so that they would correspond to the ages in the EPI-Norr study as closely as possible, since the latter study was planned to be used for comparisons in Study II. Individuals who had visited a dental clinic during the last three years (a total of 4410 individuals) were included in the sampled population; see Figure 4. Matched controls were taken from the register of dental records at the Public Dental Health Service in Norrbotten County. The sample size was calculated from an assumption of the prevalence of complete tooth loss of 1% and 5% in each group respectively, a significance level of 5% and a power of 80%. The prevalence of complete tooth loss in the previous EPI-Norr study (19) of the

general population in the same geographical region showed a prevalence of 0% in age group 50, 2.6% in age group 65 and 13.5% in age group 75 years. Two hundred and fifty (250) subjects were selected in the study group and 250 in the matched group, resulting in 500 subjects; see Figure 4.

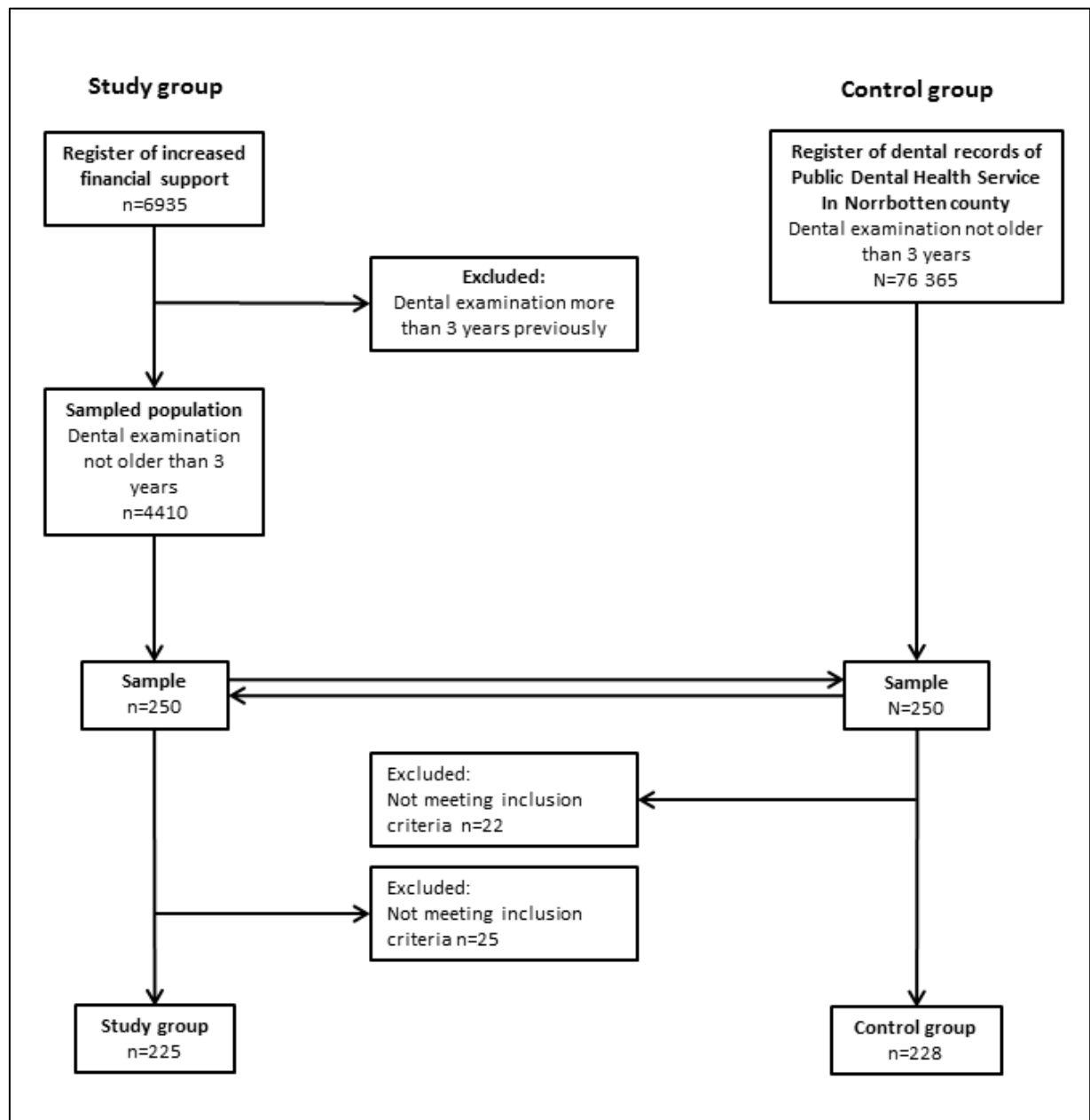


Figure 4. Study I. Flow chart

Sampling for the study population in Study II was done with stratification according to the strata defined in Study I. The sampled population included all individuals in the register, a total of 6987 individuals; see Figure 5a. Sample size estimation was based on mean number of teeth in Study I. To detect a difference of two teeth in the variable mean number of teeth between this study and the EPI-Norr study (19), with a power of 80% and a significance level

of 5%, 352 subjects were needed in the study group. Both regular and non-regular dental visitors were included in the study group, which also had been the criteria in the EPI-Norr material; see Figures 5a and 5b.

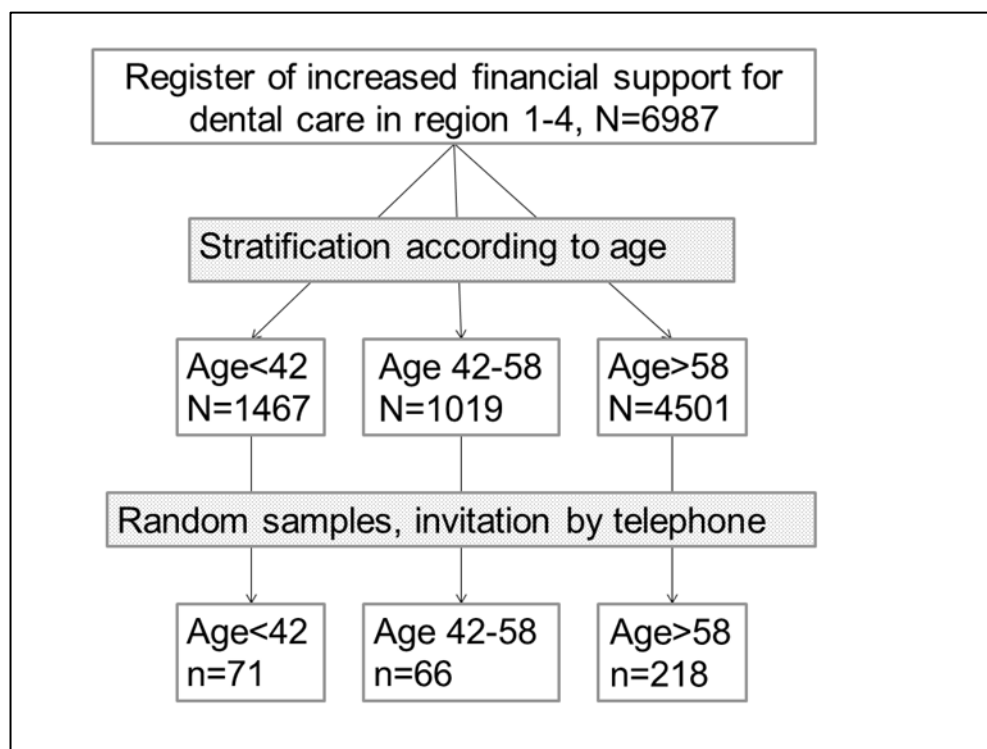


Figure 5a. Study II. Flow chart of the study group

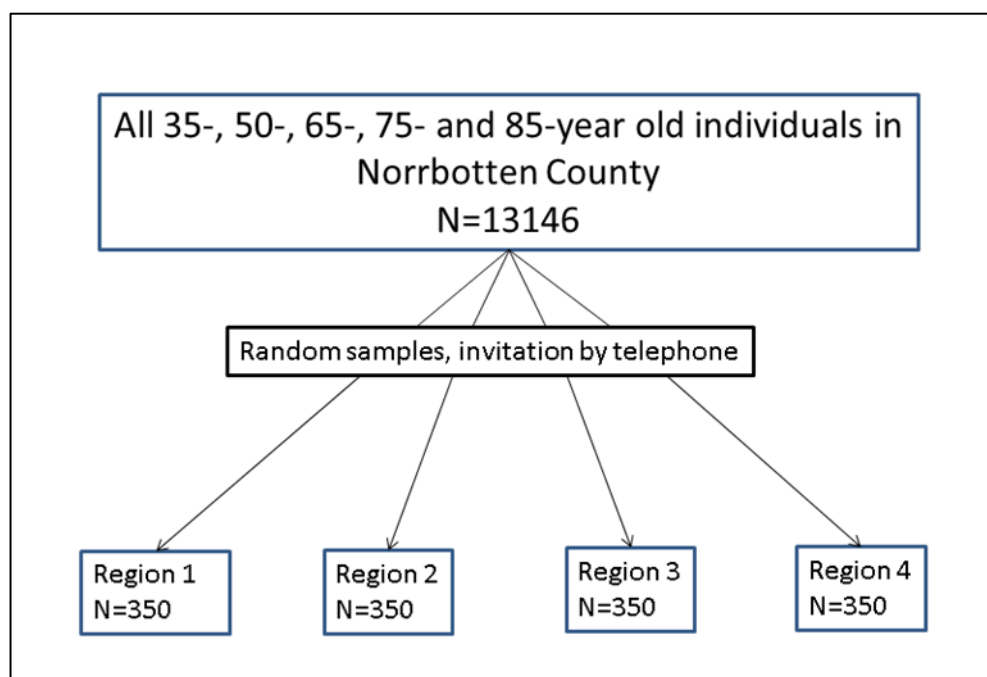


Figure 5b. Study II. Flow chart of the EPI-Norr Study

The study population in Study III was recruited from the study population in Study II. After the clinical examinations in Study II, the subjects' ability to complete questionnaires was assessed. Participants who were regarded as unable to understand the questionnaires were excluded, a total of 67 (19%) individuals, leaving 288 who were invited to participate; see Figure 6.

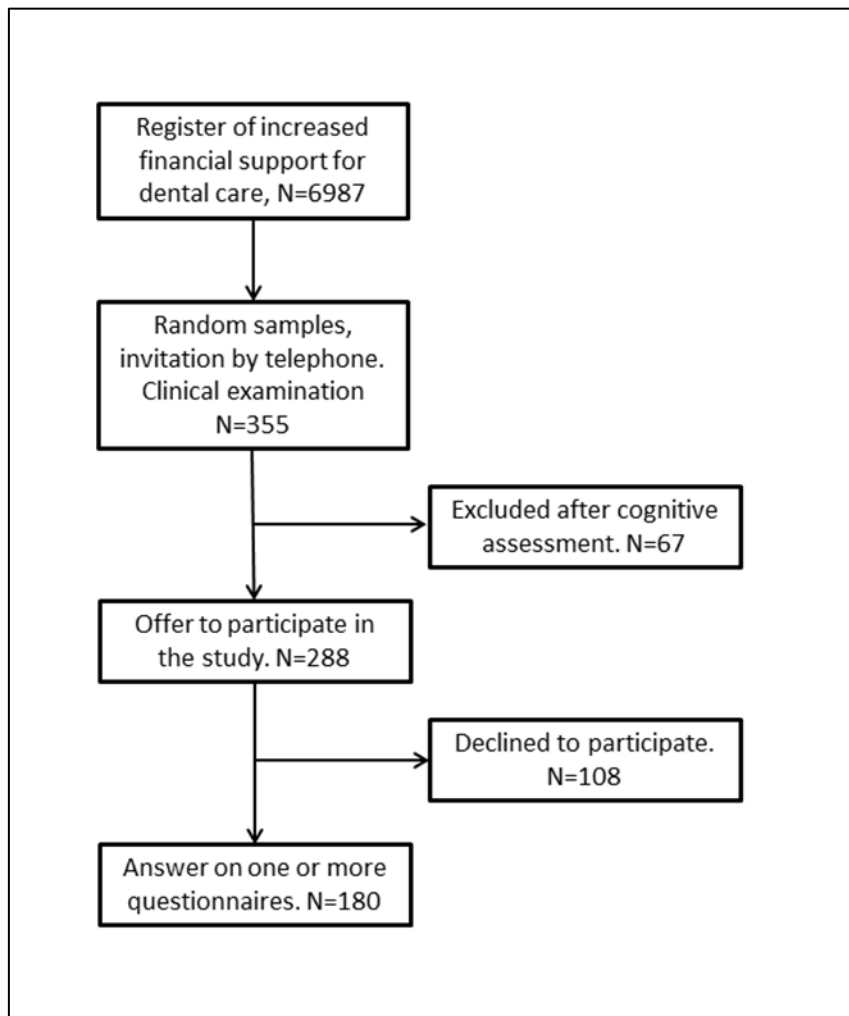


Figure 6. Study III. Flow chart

In Study IV, selection was made through theoretical sampling (89, 91-93, 96) from dental records at the Department of Oral Surgery at Sunderby Hospital in Norrbotten County, Sweden. Patients who had been treated by the author were excluded. The participants were selected according to various types of functional impairments: patients with physical impairments, patients with mental and intellectual impairments and very old patients. We tried to obtain as many variations as possible according to age, sex, type of functional impairment and type of implant prostheses. The analysis was made as the interviews proceeded and guided the selection of the participants.

4.7 PROCEDURES

4.7.1 Inclusion criteria

In Studies I, II and III, the inclusion criteria were that the subject was entitled to the financial support system for persons with dependency and functional limitations and was 20 years of age or older.

In Study I, a complete dental status from a dental examination in the last three years had to be documented in the dental record.

In Study II, the subject had to be able to cooperate in a dental examination.

In Study III, the participants had to be able to understand the questionnaires.

In Study IV, the subjects had to be able to participate in an interview with or without the assistance of an advocate.

4.7.2 Exclusion criteria

In all studies, subjects who had been treated by or had some relation to the examiner were excluded. Subjects who could not meet the inclusion criteria were excluded.

In Study I, subjects who had died after the sampling process were excluded.

4.7.3 Assessment of ability to complete questionnaires

In Study III, an assessment was made of the subjects' ability to complete the questionnaires in the study. As a complement to the researcher's assessment, the Short Portable Mental Status Questionnaire (SPMSQ) created by Pfeiffer was used (97, 98). The instrument consists of ten questions and the results are categorized in four levels from normal to severe cognitive impairment. It is not a test for diagnosis, but rather a brief screening.

4.7.4 Advocacy

If the subjects in Studies II and III had difficulties understanding the procedure in the clinical examination or understanding the questionnaires, there had to be an advocate who was regarded as knowledgeable with respect to the patient's situation and needs. The advocate was not used as a proxy, but rather used to help the subject understand and answer the questions.

Participants in Study IV who were unable to speak were asked to appoint an advocate not only for consent, but also for interpreting the interview questions and answers. In this study, this person was named 'representative'. The reason for including persons who could not speak was that they actually had undergone treatment with dental implants. In the planning process for the implant treatment, the dentist must have communicated with the patient in some way. Verbal consent was given by the participant or his or her representative. When a representative was used, all questions were formulated to the participant, who could express

him or herself with gestures, mimicry and sometimes verbal phrases, which could be interpreted by the representative. The participant had the opportunity to ask questions during the interview. Attention was paid to reactions of the participants who could not speak, to make it possible for the representative to explain in greater detail and sometimes help the participant to ask questions.

In all studies, when an advocate was needed, each advocate and participant filled out a form together, indicating their relationship.

4.7.5 Instruments

In Study III, we used one instrument for measuring HRQoL, two instruments for measuring OHRQoL and four supplementary questions.

RAND-36

RAND-36 is an instrument for measuring HRQoL. It consists of 36 items and was developed from the RAND Medical Outcomes Study (MOS) and has been validated in Sweden (99-103). It is a generic profile-based instrument and measures the following eight health concepts:

- Physical functioning (PF)
- Role limitations caused by physical health problems (RP)
- Role limitations caused by emotional problems (RE)
- Social functioning (SF)
- Emotional wellbeing/mental health (MH)
- Energy/fatigue (VT)
- General health perceptions (GH)
- Change in perceived health during the last 12 months (HF)

Higher values indicate better HRQoL. Each concept was analysed separately.

GOHAI

GOHAI, the General Oral Health Assessment Instrument, measures OHRQoL and was developed in the United States (104). It has been validated both in Sweden and other countries (80). It consists of 12 items in three dimensions: 'physical function', 'psychosocial function', and 'pain and discomfort' (39, 80, 105). The responses are scored on a Likert scale with five categories (always, often, sometimes, seldom, never). We used the additive method Add-GOHAI to calculate the scores in which the response codes for the items are summarized and range from 12 to 60.

OHIP-14

OHIP-14, the short version of the Oral Health Impact Profile (106) has shown good reliability, validity and precision in several languages, including Swedish (107). The responses to the OHIP-14 items are scored on a Likert scale with five response categories for each question as in GOHAI (106-108). We used the additive method to calculate the scores, which range from 14-70. A high score on GOHAI indicates better oral health, whereas with OHIP-14, a high score indicates worse oral health.

Supplementary questions:

Four newly developed questions concerning oral function and prosthetic treatment needs were also distributed in Study III with the intention to further explore some important areas:

- How do you experience the situation after you lost the teeth?
- Why did you get a new denture?
- Can you chew well with your teeth?
- How do you evaluate your chewing capacity?

4.7.6 Study variables

In Study I, data was collected from dental records and the variables were number of teeth, tooth loss and prosthetic replacements in different regions of the jaws.

In Study II, data collection was performed through clinical examinations. The collected variables were: number of teeth, Eichner index (109, 110), presence, type and condition of dental prostheses, type and condition of prosthetic replacements, and “realistic” treatment needs (111); see Figure 7.

In Study III, data was collected through questionnaires. The clinical variables from Study II were used together with the additive scores of GOHAI (80, 104) and OHIP (107, 108), the different concepts of RAND-36 (78) and the supplementary questions. See Table 1.

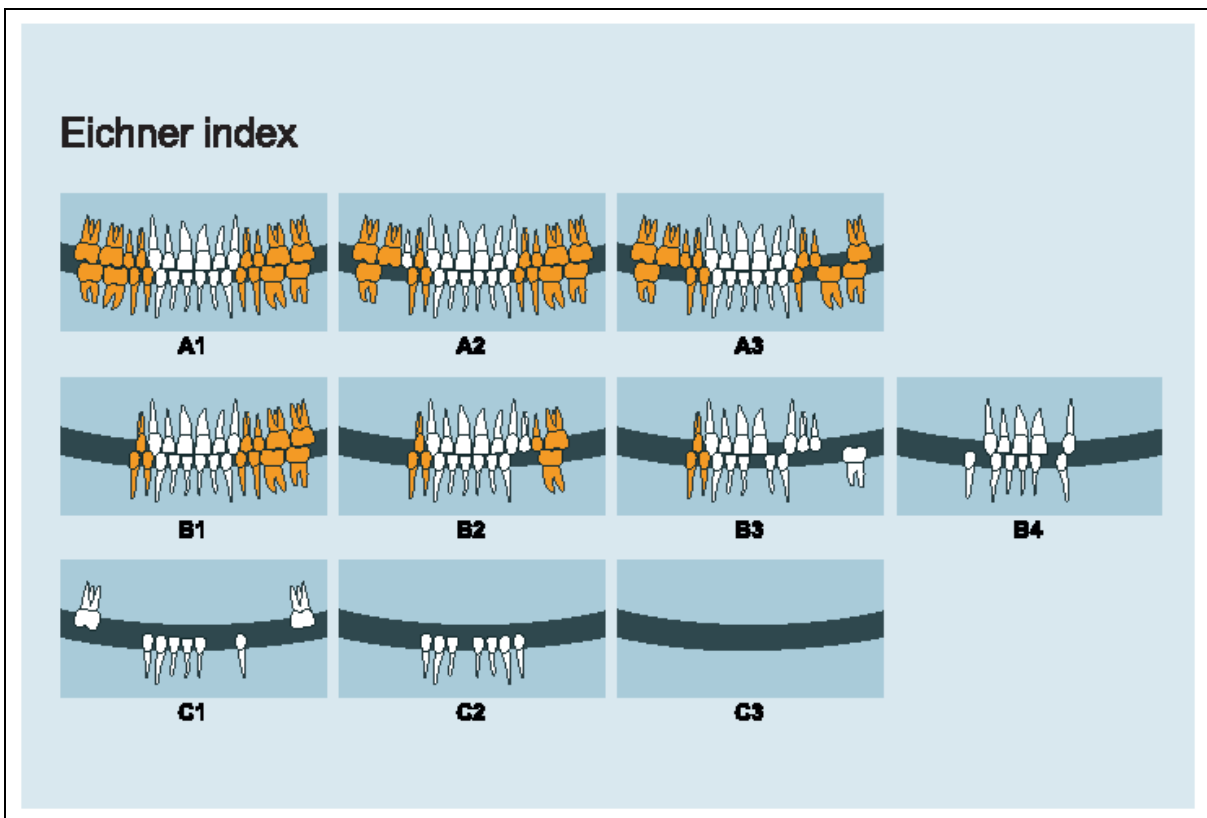


Figure 7. Eichner index. There are four posterior support zones in the Eichner index, defined as number of occlusal contacts between premolars and molars. Group A has occlusal contacts in all four posterior support zones. A1 has no missing teeth in maxilla and mandible. A2 has at least one missing tooth in either mandible or maxilla. A3 has at least one missing tooth in both the mandible and maxilla. B1, B2 and B3 have posterior occlusal contacts in three, two and one zone, respectively. Group B4 has occlusal contact in the anterior region only. Group C1 has at least one tooth in both the mandible and maxilla without any occlusal contact. Group C2 has at least one tooth in either the mandible or maxilla, and group C3 is fully edentulous in both arches (109, 110).

4.8 MISSING DATA

In Study I, 47 subjects (9.4%) of the 500 sampled were excluded; see Figure 4. Of those who were excluded, 40% had died after the sampling process, 32% had missing data in the records without any explanation, in 13% the records were not available because the subject had been treated by a private dentist, in 9% the wrong category was recorded and in 6% there were missing data in the records because the subject had been too weak and tired for an oral examination.

In Study II, 30% of those who could be reached did not want to participate or were not healthy enough to participate in an oral examination; see Figure 5a. In the EPI-Norr study which was used as control, data were lacking in 35% of those who were invited due to health problems; see Figure 5b. As in the study population, some of the subjects could not be reached because they had died or moved away after sampling.

In Study III, the 355 participants in Study II were invited to participate. 19% of them were excluded because they were regarded as unable to understand the questionnaires. Of the remaining 288 subjects, 38% did not want to participate or were not healthy enough; see Figure 6.

In Study IV, an information letter was sent to twenty-three participants. In the ensuing telephone conversation, 17 agreed to participate in the study. One person was not available by telephone, one person didn't have time and three were too sick or too tired to participate in the study.

4.9 STATISTICAL METHODS

We used Statistical Package for the Social Sciences, SPSS, version 22 (Study I) and version 24 (Study II and III) for all statistical analyses (112). In all tests, the null hypothesis was that there is no difference between the groups, and a p-value of less than 5% was used as the limit for significant results.

Comparisons between group means were made with independent samples *t*-test, and the Wilcoxon rank sum test. For proportions, we used chi-square tests. In comparisons between more than two groups, ANOVA was used. We also used the R system together with the PropCIs package (113). Associations between variables have been investigated with tables and regression models including correlations.

5 RESULTS

5.1 RESULTS OF THE STUDY POPULATION IN TOTAL

5.1.1 The participants

453 subjects aged between 20 and 96 were included in Study I (Table 3).

Table 3. Participants in Study I

	Men	Women	95% CI	p	Total
n (%)	212 (46.8)	241 (53.2)		0.611	453 (100)
Mean age	53.2	61.7	-12.36 to -4.59	<0.001	
	Study	Control			
n	225	228			453
Mean age	58.7	56.8	-2.03 to 5.91	0.337	
% Women	52.0	54.4		0.611	100

Pearson Chi-Square, Independent *t*-test

Study II included 355 subjects between 20 and 101 years; see Table 4.

Table 4. Participants in Study II

Study group in total	Men	Women	95% CI	p	Total
n (%)	155 (43.7)	200 (56.3)			355 (100)
Mean age	55.1	68.7	-14.0 to -5.3	<0.001	
The categories	Men	Women	Total	Mean age	(± SD)
	n (%)	n (%)	n (%)		
<i>a. Elderly in nursing homes</i>	43 (30.7)	97 (69.3)	140 (100)	83.1	10.2
<i>b. Persons with certain functional impairments</i>	76 (52.1)	70 (47.9)	146 (100)	47.0	15.3
<i>c. Home-care patients with dependency and functional limitations</i>	28 (66.7)	14 (33.3)	42 (100)	63.8	18.7
<i>d. Independent persons with long-lasting functional limitations with extensive need for dental care due to illness that causes functional impairments.</i>	8 (29.6)	19 (70.4)	27 (100)	63.4	13.9

Independent *t*-test

180 subjects between 20 and 97 years of age answered one or more questionnaires in Study III. For more information about the study population, see Table 5.

Table 5. Participants in Study III

The study in total	Men	Women	95% CI	p	Total
N (%)	80 (44)	100 (56)			180 (100)
Mean age	56.5	63.4	-13.25 to -0.65	0.031	
The categories	Men n (%)	Women n (%)	Total	Mean age	(± SD)
<i>a. Elderly in nursing homes</i>	16 (36.4)	28 (63.6)	44 (100)	84.7	9.2
<i>b. Persons with certain functional impairments</i>	43 (48.3)	46 (51.7)	89 (100)	46.4	16.5
<i>c. Home-care patients with dependency and functional limitations</i>	15 (65.2)	8 (34.8)	23 (100)	64.4	18.5
<i>d. Independent persons with long-lasting functional limitations with extensive need for dental care due to illness that causes functional impairments</i>	6 (25.0)	18 (75.0)	24 (100)	63.5	12.2

Independent t-test

17 subjects with a mean age of 70 years (range 33–87 years), 7 men and 10 women, participated in interviews in Study IV.

5.1.2 Tooth loss and prosthetic replacements

The results from Study I showed that there was a clear difference in mean number of teeth with a lower mean number in the study group compared with the matched control group. 16% of the subjects in the study group had no teeth compared with only 2% in the matched group ($p=0.011$). In Study II, the mean number was lower in the study group at all ages except for the eldest in comparison with the EPI-Norr study. 20% were edentulous, compared with 7% in EPI-Norr ($p<0.001$).

In Study I, there were differences in tooth loss between men and women. Women had a higher proportion of totally edentulous upper jaws and more tooth loss in the lateral regions in the lower jaws compared with men.

The results from Study I showed that dentures in the upper jaws were twice as common in the study group compared with the matched control group (27% vs. 12%, $p<0.001$) and in the lower jaws, dentures were three times more common in the study group compared with the control group (18% vs. 6%, $p=0.001$). In Study II, 15% of the study group had complete dentures in both jaws, compared with 6% in EPI-Norr ($p<0.001$). The prevalence of complete dentures in the upper jaws in Study II was 24% in the study group and 14% in the EPI-Norr study ($p<0.001$). In the lower jaw, the prevalence was 15% in the study group and 6% in the EPI-Norr study ($p<0.001$). There was no difference in the prevalence of partial dentures between the groups in Study II.

In Study II, 42% of the complete dentures in the upper jaw were in poor condition among the subjects in the study group, 20% were acceptable and 38% were in good condition. For dentures in the lower jaw, the proportions were 51% poor, 19% acceptable and 30% good. For complete dentures in both jaws, 51% were in poor condition and 30% good ($p<0.001$). Tooth-supported and implant-supported prostheses in both jaws in Study II were mainly in good condition.

In Study II, A-scores of the Eichner index were lower in the study population and C-scores were higher compared with the EPI-Norr study, both with and without removable prostheses in place. In the results of a complementary analysis, this difference could be seen in all age groups; see Figure 8.

There were more complete dentures and fewer tooth- and implant-supported prostheses in the study groups in both Study I and Study II compared with the matched controls in Study I and the Epi-Norr study. Implant-retained overdentures were rare in both studies; only one implant overdenture was found in Study I.

Study II showed that the treatment needs according to removable prostheses were higher in the study group compared with the EPI-Norr study. Treatment needs with respect to tooth- and implant-supported prostheses did not differ between the groups. The need for referral to a specialist was higher in the study group than in the EPI-Norr study.

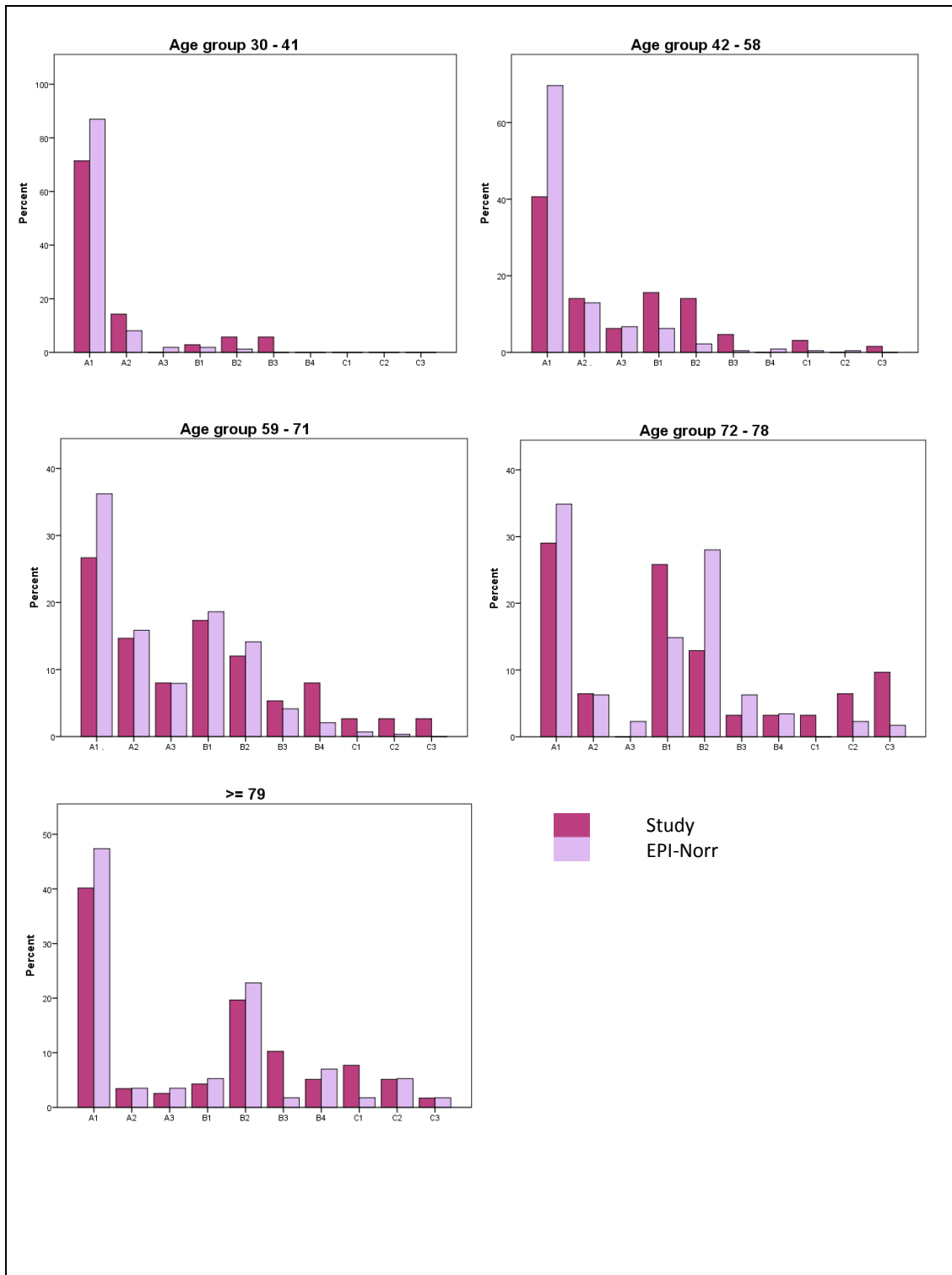


Figure 8. Eichner index with prosthesis in different age groups in the study population compared with the EPI-Norr population.

5.1.3 OHRQoL and HRQoL

In the study population, the mean GOHAI score was 50.1 (95% CI 49.0-51.3) and mean OHIP-14 score was 23.9 (95% CI 22.3-25.6). The associations between GOHAI/ OHIP-14 and RAND-36 were weak.

There was a weak correlation between number of teeth and GOHAI (Spearman's rho 0.161, $p=0.034$) and no significant correlation between number of teeth and OHIP-14.

There were weak associations between complete dentures in one or both jaws and the GOHAI/OHIP-14 scores. The associations were stronger to the RAND-36 concepts: Physical Functioning, Role Functioning Physical and Role Functioning Emotional. The same pattern was seen for 'Type of prosthetic replacement'.

The associations between 'condition of the prostheses' and the GOHAI/OHIP-14 scores were weak. Prostheses in good condition scored highest on the physical dimensions of RAND-36, indicating better HRQoL.

The GOHAI scores did not vary between subjects with different Eichner levels and OHIP-14 showed lower values, suggesting better OHRQoL, for participants with Eichner level C, i.e. fewer support zones. The scores of the Physical Functioning concept in RAND-36 showed a clear association with the levels of Eichner index with higher values for level A and lower values for level C.

5.1.4 Supplementary questions regarding prosthetic replacements

Two-thirds of the study participants answered that they could manage after they had lost their teeth, that they could chew well and that they could eat all kinds of foods (Table 9). The correlation between each of the last two questions and Eichner index was low (Spearman's rho 0.261, $p=0.001$ and Spearman's rho 0.171, $p=0.033$, respectively). The majority of the participants answered that they did not know why they got a new denture or that the dentist had said it was the only possible option (Table 6).

Table 6. Questions about tooth loss, prosthetic treatment and chewing capacity.

Questions		a. Elderly in nursing homes	b. Persons with certain functional impairments	c. Home-care patients with dependency	d. Independent individuals	Total
“How do you experience the situation after you lost the teeth?” n (%)						
	I can manage as it is now	21 (68)	18 (47)	10 (67)	9 (75)	58 (60)
	I have not thought about it	9 (29)	11 (29)	2 (13)	2 (17)	24 (25)
	I sometimes need some help	1 (3)	9 (24)	3 (20)	1 (8)	14 (15)
	Total	31 (100)	38 (100)	15 (100)	12 (100)	96 (100)
“Why did you get a new denture” n (%)						
	I was pleased with my last denture (n)	7 (28)	1 (12)	0 (0)	1 (25)	9 (21)
	The denture is for temporary use	0 (0)	0 (0)	1 (20)	0 (0)	1 (2)
	The dentist said it was the only possible option	10 (40)	2 (25)	0 (0)	2 (50)	14 (33)
	I wanted a fixed protheses but could not afford it	1 (4)	0 (0)	1 (20)	1 (25)	3 (7)
	I don't know	7 (28)	5 (63)	3 (60)	0 (0)	15 (36)
	Total	25 (100)	8 (100)	5 (100)	4 (100)	42 (100)
“Can you chew well with your teeth?” n (%)						
	Yes, very well	24 (59)	51 (65)	12 (80)	11 (55)	98 (64)
		9 (22)	13 (17)	1 (7)	4 (20)	27 (18)
		5 (12)	5 (6)	1 (7)	4 (20)	15 (10)
		2 (5)	4 (5)	0 (0)	1 (5)	7 (4.5)
	No, very poorly	1 (2)	5 (6)	1 (7)	0 (0)	7 (4.5)
	Total	41 (100)	78 (100)	15 (100)	20 (100)	154 (100)
“How do you consider your chewing capacity?” n (%)						
	Capacity to eat all kinds of foods	20 (48)	54 (69)	13 (87)	11 (55)	98 (63)
		12 (29)	10 (13)	2 (13)	4 (20)	28 (18)
		8 (19)	8 (10)	0 (0)	3 (15)	19 (12)
		2 (5)	2 (3)	0 (0)	2 (10)	6 (4)
	Severely impaired chewing capacity, need of special diet	0 (0)	4 (5)	0 (0)	0 (0)	4 (3)
	Total	42 (100)	78 (100)	15 (100)	20 (100)	155 (100)

5.1.5 Experience of receiving and living with dental implants

The identified core category was *'Implant treatment is a process of normalization'*. It was related to four other categories: *'The functionally impaired are also entitled to dental care'*, *'Edentulousness is a burden for functionally impaired individuals'*, *'There is interaction between implant treatment and other aspects of life'* and *'It is important to understand the implications of implant treatment'*. The categories were derived from codes identified in the transcribed interviews.

The core category, *'Implant treatment is a process of normalization'* describes the informants' experience that treatment with dental implants had made them feel more normal. Treatment with dental implants enhanced the informants' perceived quality of life in terms of better self-image and improved functioning. Being treated with dental implants had positively influenced social activities such as eating in the company of friends, talking and laughing. The experience of better aesthetic appearance was also important. Good oral function and appearance was especially important for informants with mental or intellectual impairments, particularly for avoiding stares from others.

The category *'The functionally impaired are also entitled to dental care'* describes that many informants had not experienced that they had equal rights to dental care. In some cases, contributions from relatives had been necessary to make the implant treatment possible. Cost had for some informants been a factor for the choice of earlier prosthetic therapy.

The category *'Edentulousness is a burden for functional impaired individuals'* explains how the feeling of being different had been enhanced when they had lost teeth and how impaired oral function became an extra burden to being disabled. Poor oral health and ill-fitting dentures had been experienced as a social handicap and many of the informants had avoided social activities. Intimate relations had been obstructed before implant treatment. Some of the informants had experienced a deterioration of prosthetic function due to resorption of the jawbone and illness such as stroke. Others had never been able to cope with dentures. One motivating factor for implant treatment was eating problems.

The category *'There is interaction between implant treatment and other aspects of life'* deals with the impact of circumstances of life on the experience of the treatment procedure, the demand for and the outcome of implant treatment. It was not the clinical and technical difficulties of the treatment that were most troublesome for the informants. It was other factors, such as previous dental experiences, difficulties understanding the treatment process due to narcosis, and experiencing the duration of the process from operation to the prosthetic construction as being too long. Some of the informants perceived better health after the implant treatment.

The category *'It is important to understand the implications of implant treatment'* refers to aspects of autonomy and information. These issues seem to have been important throughout the process, but especially when the informant was not satisfied with the implant treatment. One reason for dissatisfaction was insufficient information about difficulties and risks and

information about different options of prosthetic constructions before treatment. Another reason was lack of opportunity to participate in decisions about aesthetic design of the teeth. Lack of instruction in how to clean the new prosthesis was also a reason for displeasure. Some of the informants stated that they had not received information about the importance of regular check-ups.

5.2 RESULTS OF THE CATEGORIES IN THE STUDY POPULATION

5.2.1 Elderly in nursing homes

Elderly in nursing homes was the second largest of the categories in the study population. The mean age in this category ranged between 79 and 83 in the different studies and the proportion of women between 64% and 70%.

Study I showed that the subjects in this category differed most from their matched controls and had the fewest teeth of all categories in the study group. Also in Study II, elderly in nursing homes had the lowest number of teeth of the categories. In comparisons between age groups in Study II and the EPI-Norr study, there was no significant difference in mean number of teeth in the two eldest groups.

Elderly in nursing homes had the highest mean score for GOHAI and the lowest for OHIP-14, indicating better OHRQoL.

A majority of the elderly thought that they could manage with the current situation after they had lost teeth and that they could chew well. Half of them answered that they could eat all kinds of foods and the majority of them had got their new denture because the dentist had told them it was the only possible alternative or because they had been pleased with their last denture; see Table 6.

5.2.2 Persons with Certain Functional Impairments

Persons with Certain Functional Impairments was the largest category in Studies I, II and III. The mean age in the category varied between 43 and 48 in the studies and the proportion of women between 46% and 52%.

The mean number of teeth was lower in this category compared with the general population in both Study I and Study II. The majority of participants in this category were in the 42-58 age group in which the Eichner index differed most from the subjects in the EPI-Norr study; see Figure 8.

In Study I, 3% of the subjects in this category had complete tooth loss and they were treated with dentures. In Study II, 6% had complete tooth loss and they were treated with dentures or had no prosthesis.

There were no clear associations between OHRQoL or HRQoL and oral status in this category. However, OHIP scores were higher for prostheses in poor condition, indicating worse OHRQoL.

Half of the subjects thought that they could manage with the current situation after they had lost their teeth. However, the answer ‘I sometimes need some help’ was most common among subjects in this category. The majority reported that they could chew well and that they could eat all kinds of foods. The reason why they had got a new denture varied; see Table 6.

5.2.3 Home-care patients with dependency and functional limitations

Home-care patients with dependency and functional limitations was the smallest of the categories with care-dependency. A majority of the participants had psychiatric diseases, 33% to 41% were women, and their mean age was between 62 and 64 in the studies.

There were big differences with respect to mean number of teeth and complete tooth loss, with lower mean numbers in this category compared with their matched controls in Study I. Study II showed that this category had the lowest mean number of teeth in the middle-age group.

The subjects in this category together with the subjects in the category of independent persons with long-lasting functional limitations had the lowest mean scores for GOHAI, indicating poorer OHRQoL.

The association between GOHAI/OHIP-14 and the RAND-36 Mental Health concept was stronger among subjects in this category compared with the other categories.

The GOHAI scores were lower and OHIP-14 scores higher in this category for prostheses in poor condition, indicating worse OHRQoL.

The majority of the home-care patients reported that they could manage with the current situation after they had lost teeth, that they could chew well and eat all kinds of foods. The reasons for why they had got a new denture varied; see Table 6.

5.2.4 Independent persons with long-lasting functional limitations with extensive need for dental care due to illness that causes functional impairments

The smallest category of all was the *Independent persons with long-lasting functional limitations*. The mean age in this group was 63 in both Study II and Study III and the percentages of women were 70% and 75%, respectively.

The results from Study II showed that the subjects in this category had nearly as many teeth as the younger subjects in the category *Persons with Certain Impairments*. None of the subjects in the independent category had complete tooth loss in both jaws. There was one subject with a complete denture in the upper jaw, and one with a partial denture.

The independent subjects had the highest value for OHIP-14, suggesting poorer OHRQoL. The association between GOHAI/OHIP-14 and the RAND-36 General Health concept was stronger than in other categories.

For subjects in this category, the correlation between number of teeth and Mental Health (RAND-36) was higher (Spearman's rho 0.536 $p=0.018$).

OHIP-14 scores were higher, indicating a poorer OHRQoL among subjects with prostheses in poor condition in this category.

The majority of the subjects in this category thought that they could manage after they had lost teeth or that they had not thought of it. Half of the subjects reported that they could chew well and that they could eat all kinds of foods. The reasons for why they got a new denture varied; see Table 6.

6 DISCUSSION

6.1 GENERAL DISCUSSION

6.1.1 Tooth loss in the general population

Contemporary research has shown that the prevalence of tooth loss has decreased in many countries and people retain their teeth in higher ages (16, 35, 114). One example is the results of the Jönköping study from 2015 (18), in which there were no subjects with complete tooth loss and dentures younger than 80 years. However, it is difficult to compare rates of tooth loss between countries as many factors influence the prevalence, such as socioeconomic factors, living situations, lifestyle, etc. (70). Sweden is one of the countries with the highest percentage of fully dentate individuals (20) but there have been great geographical differences in Sweden historically, with poorer oral health in the north part, especially in Norrbotten County. These differences are about to be diminished but the eldest inhabitants in Norrbotten County today have higher rates of tooth loss as they belong to the generation that did not have access to dental care during their childhood and adulthood. This is one explanation for the higher levels of tooth loss in the older ages in the control population in Study II of this thesis (19).

The general trend globally is that tooth loss appears later in life than it used to. This has consequences as it is more complicated to replace teeth in very old people. At high ages it is more difficult to adapt to dentures and it can be too challenging for the patients to undergo treatment with fixed prostheses. At the same time, tooth loss may have great implications for the oldest persons, with impact on chewing, nutrition and with possible effects on brain function. The most important is thus to prevent tooth loss also among the eldest, but more knowledge is needed to facilitate treatment of tooth loss when it appears.

6.1.2 Tooth loss in the study population

Previous research shows higher levels of tooth loss among individuals with different kinds of functional limitations and care-dependency compared with the general population, especially among elderly (22-26, 69). Among elderly with care-dependency, the prevalence of complete tooth loss varies between different studies from around 30% to 50% (9, 27, 29, 30, 115-118), to compare with 33% in our results from category *a*, *Elderly in nursing homes* in Study I and 41% from Study II.

The oral health of many elderly people has shown to deteriorate during the period in life leading up to dependency (28) so for some of the nursing home residents in this thesis, the poor oral health may have arisen before they moved into the nursing home. Correspondingly, the same could be said of some of the oldest subjects in the EPI-Norr study; many of them were soon on their way to be cared for in a nursing home. This may also have influenced the small difference in prevalence of tooth loss in the eldest group between the study population and the EPI-Norr study.

In our studies, the *Persons with Certain Functional Impairments* (category *b*) had the highest mean number of teeth of the categories in the study population. However, there was a difference of three in mean number of teeth compared with the matched group from the general population in Study I. The financial support system in Sweden allows preventive dental care at a reduced cost to individuals in this category (38). Yet our studies show that the burden of oral diseases is considerably higher for these individuals compared with a general population. As for the elderly in nursing homes, treatment with dental prostheses may be complicated for people in this category (119, 120). In our studies there were some subjects who had not received treatment for lost teeth, which sometimes is the best option. However, in the interview study there were subjects from this category who had experienced troubles in getting help despite a great perceived need. For some of the subjects in the interview study, their relatives or representatives had to struggle for the opportunity to get implant treatment.

The prevalence of tooth loss among *Home-care patients with dependency* in category *c*, which basically included subjects with psychiatric diseases, differed substantially from the prevalence in the general population. Studies from different countries have reported that individuals with psychiatric diseases suffer from poor oral health (23-25). An Australian study showed that people with severe mental illness had 3.4 times the odds of having lost all their teeth than the general community (25). The authors' explanations were that people with mental illness may have other priorities than their oral health, which results in poor oral hygiene; that psychopharmacological drugs can contribute to dry mouth, which is a risk factor for oral disease; and that mental illness can lead to dental fear. Another explanation may be that social isolation is more common among people with psychiatric disorders, which makes it more difficult for these individuals to seek help. Better cooperation between the dental and general healthcare services could facilitate these patients getting help with their oral disorders.

The mean number of teeth of the *Independent persons with long-lasting functional limitations*, category *d*, was near the level of the younger persons with certain functional limitations in category *b* despite a much higher mean age (64 vs. 47). None of these individuals had complete tooth loss. They had long-lasting chronic illnesses such as neurological diseases, but they were not completely care-dependent. According to ICF (85), they had problems in body structure and function, but they were able to perform certain activities. Environmental and personal factors enabled participation in society to some extent. The results from the studies in this thesis indicate that the influence of care-dependency on oral health is stronger than the influence of special diagnosis.

6.1.3 Consequences of tooth loss

One of the possible consequences of tooth loss is impaired chewing function, which in turn may have an impact on nutritional factors and cognition (13, 53, 65, 121-124). However, chewing is a multi-dimensional activity, and is not completely dependent on the number of occluding tooth units. For example, the proprioception from natural teeth is important for the neurological control of the chewing process (53). Still, the influence of posterior occluding

tooth units seems to be important especially for chewing efficiency and nutrition (125, 126). People with fewer tooth units choose food which is easy to chew and avoid fresh fruit and vegetables (121, 124, 125). In this perspective, the results of the Eichner index in Study II should be considered. The study participants had fewer A-scores compared with the EPI-Norr participants in all ages (see Figure 8), indicating fewer posterior tooth units which may have an impact on nutritional status in the long run.

Other consequences of tooth loss that have been reported in earlier research in the general population are impact on self-esteem, self-image, social relations and participation in different life situations (1-4, 6, 31,). These effects were also seen among persons with functional limitations in Study IV and treatment with dental implants seems to have been equally important for the participants in this study as for persons from the general population

6.1.4 The financial support system

Financial support systems have implications on the dental care services in a country. The increased financial support system for persons with dependency and functional limitations in Sweden is based on cost effectiveness (38). Cost effectiveness means that there has to be a reasonable relationship between cost and effect measured in better oral health and increased quality of life. In the choice between two treatment options with approximately the same health benefit, the one with the lower cost should be chosen so that the resources in the system will be sufficient for more patients.

This principle is important for the system to work. However, sometimes individuals may suffer from it. The regulations are very restrictive concerning fixed prostheses, especially implant treatments. Treatment with dentures is the first choice. If the patient cannot adapt to dentures, the alternative is a fixed prosthesis or no treatment at all. In these cases, the situation for the individual should be prioritized.

The increased financial support system includes both a dental outreach programme with annual check-ups by dental hygienists and entitlement to substantial dental care at a low cost (38), but according to The Swedish Agency for Health and Care Services Analysis (Vårdanalys) (127), only 40% of those who are entitled to the special financial support system take advantage of the reform. Some of the subjects in Study II, especially elderly denture-wearers in nursing homes, had not visited a dentist for decades. Dental care may not have been their first priority in life. However, many benefits may be achieved if the elderly can be encouraged to join a recall system for dental care (128, 129). Oral disorders will be detected at an early stage, which will reduce the risk of problems with both oral and general health.

Sometimes a misunderstanding regarding the interpretation of the regulations of the increased financial support system in Sweden occurs. Both nursing care personnel and dental care personnel may believe that the outreach programme can replace a recall system with dental examinations at a dental clinic. It is important to emphasize that the outreach programme is only a complement to regular check-ups at dental clinics. However, the general health status

of many of these patients makes it difficult to visit a dental clinic. For this reason, there should be other options to make dental care available for these patients.

6.1.5 Prosthetic replacements

There is a notion that dentures are a final solution to the “dental problem” for elderly, and that denture-wearers never need check-ups by dentists. This has also been reported by other authors from other countries (32). During our data collection for Studies III and IV, we recognized that some dental clinics had removed the denture-wearers from their recall system as they expected the patients to call if they needed help. The results from Study IV indicate that persons with dependency and functional limitations, especially elderly in nursing homes, have a reduced ability to self-report. This was also obvious during the data collection for Study III. Many subjects had lived with poor prosthetic conditions for a long time but at the time of our data collection, a majority of them were too seriously affected by disease to make any interventions possible. Regular maintenance of the dentures would probably have made their oral situation more comfortable. According to evidence-based guidelines in a publication by the American College of Prosthodontics regarding the care and maintenance of complete dentures, they should be checked annually by a dentist (130).

Studies show that dentures, if they are optimal, can be well-functioning and be an ideal prosthetic alternative (32, 71). The treatment is non-invasive and cost-effective and dentures are easy to clean (32). However, some patients have difficulties in coping with dentures; the preconditions for dentures may be poor for anatomical, psychological or behavioural reasons (120, 131, 132). Dental implants may be an option in these cases. In our study, there were some subjects with care-dependency who had not been offered this alternative despite great needs. The reasons, besides the regulations in the financial support system, may be that the patients deny the offer (133) due to fear of pain, fear of complications or social embarrassment (133). It has also been shown that older patients were more satisfied with poorly fitting dentures and were less prepared than younger patients to undergo a more complicated treatment (134).

As treatments with dental implants have become more common in the last decades, there have been worries about increased prevalence of peri-implant infections among elderly with care-dependency. In Study II, 8% of the study participants older than 72 years had some kind of implant prosthesis. These implants had been installed before the subjects had become care-dependent. The results showed that complications from dental implants were not very common and this is supported by results from other studies (135-137).

It should be emphasized that individual indications is the base for all treatments and that all dental implants must be followed up, especially among patients with care-dependency (120). It is mandatory to follow hygiene routines for implant patients, and if this cannot be done the implant prostheses have to be removed or converted to a conventional denture (34, 120).

A Swiss study among very old adults showed increased OHRQoL after treatment with implant overdentures (135). The results in this thesis did not show any difference in

OHRQoL between subjects with different prosthetic replacements but the results of the retrospective interview study (Study IV) point to obvious improvements in the subjects' experience of their quality of life since they had been treated with dental implants.

6.1.6 Treatment needs

Treatment needs for dental care can be expressed in different ways. Normative needs are based on the clinical diagnosis and are the needs which are assessed by a dentist. This approach tends to overestimate the 'true' need for treatment, especially among vulnerable patients such as persons with dependency and functional limitations (111).

Another approach is the need 'perceived' by the patient, which can result in an 'expressed demand' (111). This is the opposite situation from the above and was observed in our studies. The care personnel at the nursing homes and group housings thought in many cases that the care recipients would give self-reports of oral disorders, which resulted in under-treatment.

'Realistic' treatment need is another concept which is intended to be used in care-dependent elderly. It is formulated by Vigild as "a combination of the normative need, the self-perceived need and the expressed demand for treatment and takes into account the mental and physical state of the individual, as well as ethical considerations" (111). This approach is more demanding for the dental care practitioner, though in the long run it is beneficial for both the patients and society.

Another approach is formulated by Narby (138, 139). They consider treatment need as a construct of society that is developed in the interaction between the patient and the dentist with gatekeeping processes between need and demand and demand and utilization. Weak patients are disfavoured in this process. The results of our studies support this idea. The needs of persons who were not able to speak for themselves were not observed sufficiently enough.

Deciding on a prosthetic therapy can be very difficult, particularly regarding patients with care-dependency. Considerations have to be taken to medical and physiological status, psychological factors, quality of life and other individual factors (34), but should also rely on research findings. The scientific base for treatment with different prosthetic replacements among persons with dependency and functional limitations is insufficient.

6.1.7 QoL

The phenomenon of chronically ill and disabled persons who assess their quality of life as quite good is recognized in different studies (68, 140, 141). Some authors refer to the 'disability paradox' in which quality of life is described as dependent upon finding a balance between body, mind and spirit in the self and on establishing and maintaining a harmonious set of relationships within the person's social context and external environment (142). Others connect with the response shift theory (143), which says that changes occur over time within people regarding their internal standards, values, or conceptualization of quality of life as a result of the experience of ill health. Regardless of these explanations, it is important to note

that clinical parameters, self-rated oral health and quality of life cannot be assumed to be consistent (140).

The HRQoL instrument RAND-36 showed better sensitivity than the OHRQoL instruments, especially with respect to the associations between prosthetic variables or for the Eichner index with the physical dimensions of HRQoL. This has been reported earlier (9). The weak associations between clinical variables and OHRQoL in this study suggest that self-assessment of oral health and OHRQoL among care-dependent individuals may not always be correct, which has also been claimed by others (116).

The nursing homes are regulated by The Swedish Social Service Act (42). Nursing care personnel are trained to always respect the will of the care recipient, which is very important for the dignity of the recipients, but it presents a problem if care personnel just accept the care recipients' denial to receive help with daily oral healthcare. The results of the QoL study highlight the importance of regular dental check-ups in the actual population by dental professionals and the need for follow-up of dental prostheses by dentists. If the care recipients' 'perceived need' and 'expressed demand' are the only bases for usage of dental care in the actual population, it probably results in under-treatment and consequences not only for the oral health, but also for the general health of the actual population.

6.2 METHODOLOGICAL CONSIDERATIONS

The purpose of this thesis was to enhance knowledge about different factors involved in tooth loss and prosthetic treatments for persons with dependency and functional limitations. It was important to reflect on different aspects, which was the reason for different designs in the involved studies. Observational studies and studies with a qualitative approach are often held to have lower scientific value; however, these kinds of studies, with correct design and interpretation of the results, can contribute with important knowledge (81, 144, 145). The observational studies in this thesis may increase understanding of the study population and what effect the organization of nursing care, healthcare and dental care services have on how the dental care needs of the study population are met. The results may be a base for randomized clinical trials (RCT), the gold standard for evidence-based medicine, in the future.

6.2.1 Study design

One of the strengths of this thesis is that the studies are linked to each other. They are planned so that the results from Study I could be used to design Study II, and the results from this used for comparison with the results of Study III. Another strength is that the examiner in Study II was also one of the examiners in the EPI-Norr study, which was used as the control for Study II. All examiners in the EPI-Norr study had gone through a calibration programme, which paves the way for good inter-rater reliability. In this thesis, the same examiner was used in all studies.

A limitation of using the EPI-Norr study as control is that the age profile is not the same as in Study II. The study population in EPI-Norr was recruited in special ages. This approach would have been an obstacle for realizing Study II as there would have been too few participants of each age. Instead, we enrolled participants of all ages and merged them into age groups targeting the ages in EPI-Norr. This implies that Study II is not designed exactly as the control group. However, the probable better results in the ages below the target age are assumed to be compensated by the probable poorer results in the ages over the target age.

Another limitation was that due to the stratification there were more older people in the study group in Study II compared with the EPI-Norr study. This makes it questionable to compare the studies in total. However, it is important to get an overall view of the characteristics of the target population of persons with dependency and functional limitations. As comparisons also were made between age groups, this situation could be handled. The matched design in Study I provides complementary information as to how the populations differ.

It is also a limitation that data collection for EPI-Norr was performed in 2011 and in 2015 for Study II. The trend in population oral health is a continual improvement, so the delay in data collection for the study group has probably resulted in a reduction in the differences in oral status between the studies.

Studies III and IV were designed in order to gain information about the patient perspective. Study III had a quantitative approach to quality of life. All subjects answered the same questions and the results could be analysed statistically. Study IV had a qualitative approach based on individual interviews. Open-ended questions were used to gather new information. The different study designs in Studies III and IV gave complementary information. However, one interpretation of the results was that the use of common OHRQoL instruments may not be the right method to examine QoL among the population of persons with dependency and functional limitations. It seems that the interview method may be more appropriate to capture the patient perspective. The explanation for this may be that OHRQoL instruments are derived from in-depth interviews with target populations which included not only persons with dependency and functional limitations.

When reading the results of the QoL surveys in Study III, it is necessary to consider the credibility of the subjects. Some of them may not have fully understood the questions or the response options. Others may have adapted to poor oral health and could not relate to the questions. There may be several interpretations of these results.

6.2.2 Study population

The choice of merging persons with different diagnoses and functional limitations into the same study population may seem questionable but was deemed appropriate as the research questions concerning prevalence of tooth loss and prosthetic replacements were not attached to specific diagnosis and functional limitations but to the levels of dependency and functional limitations.

There are different terminologies for persons with functional limitations. In Sweden, a new terminology has been introduced which can be translated into English as ‘functional variation’, a term that points to the individual and not to predefined normality. During the work with the included studies, this terminology had not yet been adopted in dentistry.

The results of Study I showed differences between the sexes as regards tooth loss and prosthetic treatments. Further analysing these differences is a separate research question and has not been the focus of this thesis.

6.2.3 Internal validity

In Study I, the variables were collected from dental records including x-rays. These data had been registered by another examiner than the data collector. Teeth, implants and fixed prostheses could be detected in the x-rays. Removable prostheses could only be found in the written records.

In Study II, the examiner had also been one of the examiners in the EPI-Norr study, which was used as a control population. The assessments of oral status were made by the same criteria in both studies.

In Study III, we used HRQoL and OHRQoL instruments, which have been validated both in Sweden and in many other countries, but the results of the study suggest that the chosen instruments may not be valid for the study population. This finding could be a subject for further studies.

The results of Study IV are addressed by the data, which can be expressed as internal validity or credibility. Transcription and coding were managed in connection with the interviews to minimize data changing over time and thus altering the researcher’s judgment (dependability). Each step of the research process has been documented to make it possible for other researchers to corroborate the results (confirmability) (84).

6.2.4 External validity

Through studies of the situation in Sweden, conclusions can be made based on the fact that a beneficial financial support system was introduced 20 years ago. If there are differences between persons with dependency and functional limitations and the general population in Sweden, such differences may be even more accentuated in other countries.

The studies in this thesis were performed in the northern part of Sweden but the results ought to be of relevance for other researchers and clinicians dealing with questions concerning prosthodontics for persons with care-dependency, both in Sweden and in other countries.

The results from Studies I and II were compared with a control population which could be referred to as a general population. The reference for the design of both studies was the results from the EPI-Norr study, which have been compared with results from studies in other parts of Sweden and found to show similar circumstances except for in the case of the eldest.

The contradictory results of Study III reflect the complexity of the study population. More research is welcomed in order to develop other methods to capture the patient perspective among persons with dependency and functional limitations.

Regarding the external validity of Study IV, every reader has to estimate the transferability to a new context by following the described research process and deciding if the data might be open to alternative interpretations.

6.3 ETHICAL CONSIDERATIONS

All studies in the thesis were approved by the Regional Ethical Review Board in Umeå. A joint application was made for Studies I, II and III, which was approved on 24 May 2013. A separate application was submitted for Study IV and approval was given 6 April 2010.

The study population in all four studies were persons with dependency and functional limitations, a vulnerable group of whom many had difficulties in expressing themselves. These groups are seldom represented in studies, and it was thus important to facilitate their joining of this project even if some of them had cognitive impairments which could make it difficult to understand the purpose of the examinations and the questions. Information about the study was sent to the subjects by letter. They were assured confidentiality and that they could withdraw at any time. Informed consent was given in writing. If the subjects had difficulties coming to a dental clinic, they were offered a home visit. When needed, they were assisted by an advocate.

The results should hopefully benefit the studied patient groups, in respect to both dental organization and therapy planning, as well as to further research.

6.4 IMPLICATIONS

6.4.1 Clinical implications

The results may lead to a better understanding of the complexity in this population of persons with care-dependency. Every person should to a higher degree be assessed individually and their prosthetic treatment needs should be better acknowledged. The interview study shows that implant treatment can improve the quality of life and wellbeing for some of the patients with care-dependency.

Removable dental prostheses should be better followed up by dentists in order to avoid unwanted complications among the eldest. It would also benefit the most care-dependent patients if dental care could be more available, for example through full-service mobile clinics.

6.4.2 Implications for nursing care

The basis for oral healthcare among persons with care-dependency is daily dental hygiene and help to recognize oral disorders. Persons with care-dependency would benefit from a more visible integration of oral healthcare in the general healthcare and from a greater focus

by the Swedish Social Service Act on a preventive approach in order to detect and prevent oral disorders at an early stage. Oral healthcare ought to be included in the basic education for nursing and caring personnel.

6.4.3 Implications for future research

This thesis is based on observational studies and a qualitative interview study. The gender aspects need to be further studied and the financial support systems should be looked over to make it possible to individualize the prosthetic treatment plans for the patients with care-dependency. The results may also be a basis for the design of RCT studies concerning different prosthetic replacements and new technology for the actual population.

7 CONCLUSIONS

The conclusion of the thesis is that despite the favourable conditions in Sweden for oral healthcare of persons with dependency and functional limitations, there are great differences in tooth loss and how tooth loss is treated compared with a general population. There are more dentures and fewer tooth and implant-supported prostheses among these persons even if interviews show that some of them can benefit from treatment with dental implants.

However, this is difficult to confirm through validated oral health-related quality of life instruments. This vulnerable population does not often actively demand dental and oral care, and thus their needs have to be identified in other ways and by other professionals than dental healthcare services.

8 SUMMARY IN SWEDISH

Det övergripande syftet med denna avhandling var att ta fram beslutsunderlag för bedömningar och terapiplaneringar gällande protetisk behandling för personer med omsorgsbehov och funktionsnedsättningar. För detta ändamål kartlades epidemiologin av tandförluster och protetisk behandling och patientperspektivet speglades i fyra studier som genomfördes i Region Norrbotten, den nordligaste delen av Sverige. Som referens vid studiedesign användes resultaten av en epidemiologisk undersökning av munhälsa i samma geografiska region, EPI-Norr. Studiepopulationerna valdes från registret för det särskilda tandvårdsstödet i Region Norrbotten och bestod av *a. Äldre personer som bor på äldreboenden, b. Personer med särskilda funktionsnedsättningar som omfattas av lagen om stöd och service, LSS. c. Personer med omsorgsberoende och funktionsnedsättning som vårdas i hemmet. d. Personer med långvariga funktionsnedsättningar med omfattande behov av tandvård som en följd av sjukdom som orsakar funktionsnedsättning*. Resultaten från studiepopulationerna jämfördes med resultat från matchade kontroller valda från tandvårdsjournaler från Folktandvården Norrbotten i Studie I och med data från EPI-Norrstudien i studie II.

De första tre studierna var tvärsnittsstudier med datainsamling från tandvårdsjournaler (Studie I), genom kliniska undersökningar (Studie II) och via enkäter (Studie III).

I Studie I jämfördes prevalensen av tandförluster och utförd protetisk behandling med resultat från matchade kontroller som representerade den allmänna populationen. I Studie II beskrevs oralt status och protetiska ersättningar, protetiska behandlingsbehov definierades och jämfördes med data från en allmän population. Resultaten visade att studiepopulationerna hade färre tänder, en högre andel tandlösa, fler avtagbara proteser och färre tand- och implantatstödda proteser jämfört med kontrollgrupperna från den allmänna populationen. I Studie II var 42% av de avtagbara proteserna i överkäken och 51% i underkäken i dåligt skick. Studiepopulationen i Studie II hade också färre ocklusala posteriora kontakter jämfört med kontrollpopulationen i alla åldrar. Äldre på äldreboenden hade lägsta antalet tänder och högsta andelen av tandlösa, men alla kategorier hade färre tänder jämfört med kontrollpopulationerna i samma åldrar.

Forskningspersoner i Studie II som bedömdes ha förmåga att svara på frågor i en enkät, erbjöds att delta i Studie III där möjliga samband mellan tandförluster, protetiska ersättningar, oralt relaterad livskvalitet (OHRQoL) och hälsorelaterad livskvalitet (HRQoL) undersöktes. Syftet var också att undersöka om de valda livskvalitetsinstrumenten GOHAI, OHIP-14 och RAND-36 är lämpliga att använda i den aktuella populationen. Resultaten visade svaga samband mellan kliniska variabler och resultaten av enkäterna vilket indikerar att det kanske inte är lämpligt att använda vanliga livskvalitetsinstrument i populationer med omsorgsberoende. Äldre på äldreboenden hade sämst oralt status av de olika kategorierna, ändå rapporterade de den bästa livskvaliteten. Majoriteten i denna kategori tyckte att de kunde klara sig med nuvarande situation efter att ha förlorat tänder, men hälften av dem rapporterade att de inte kunde äta all sorts mat.

Studie IV var en kvalitativ intervjustudie med syfte att undersöka upplevelsen av att behandlas och att leva med tandimplantat bland personer med funktionsnedsättningar. 17 patienter med olika typer av funktionsnedsättningar som hade genomgått behandling med dentala implantat intervjuades. Analys av öppna frågor började efter den första intervjun och fortsatte parallellt med övriga intervjuer till dess ingen mer relevant information upptäcktes. I resultaten identifierades 'Behandling med tandimplantat är en normaliseringsprocess' som huvudkategori med relation till övriga kategorier; 'Personer med funktionsnedsättning har också rätt till tandbehandling', 'Tandlöshet är en börda för individer med funktionsnedsättning', 'Det är ett samband mellan implantatbehandlingen och livssituationen' och 'Det är viktigt att förstå vad implantatbehandlingen innebär'.

Slutsatsen av avhandlingen är att det trots det förmånliga tandvårdssystemet i Sverige för personer med omsorgsbehov och funktionsnedsättning, finns stora skillnader i förekomst av tandförluster och hur tandförluster behandlas jämfört med en allmän population. Det är mer avtagbara proteser och färre tand- och implantatstödda proteser bland dessa personer även om intervjuer visar att en del av dem kan ha nytta av dentala implantat. Detta är dock svårt att verifiera via validerade oralt hälsorelaterade livskvalitetsinstrument. Denna sårbara population efterfrågar inte ofta tand- och munvård och därför behöver deras behov identifieras på andra sätt och av andra professioner än tandvårdens.

9 ACKNOWLEDGMENTS

The doctoral programme has been an exciting journey and I am very grateful to the **County of Norrbotten (Region Norrbotten) and Karolinska Institutet**, which made the education possible.

Many people have supported me during my studies. First of all, I want to express my special gratitude to my principal supervisor, Associate Professor **Inger Wårdh** who has always been available for me during my time as a PhD student. You have been the perfect supervisor: critical and supportive, always with a warm heart. I have enjoyed all our conversations and I hope they will continue after my exam.

I would also like to direct my sincere gratitude to:

My co-supervisor, Professor **Karin Zingmark** who helped me to realize the doctoral education and who has contributed with important knowledge and interesting discussions.

My co-supervisor, Professor **Mats Trulsson** for contributing important advice and for reading my manuscripts.

My mentor, Associate Professor **Gunilla Nordenram** who guided me into the academic world and who has followed me throughout the process with insightful comments, with knowledge about the field of geriatric dentistry and as a kind friend.

Robert Lundqvist, statistician at the County of Norrbotten, who was not my official supervisor, but all the same the most helpful and engaged support in my work, who contributed with skills in statistics and writing as a co-writer in my papers and most of all; for making statistics fun!

Gerd Pettersson, dental nurse, who helped me as a research nurse and as a supportive friend during data collection for two of the studies in the thesis.

All personnel at the **Department of Dental Medicine** at Karolinska Institutet and **Academic Centre for Geriatric Dentistry, ACT**, for help and support.

Eva Ellert, my former boss at the Public Dental Health Service in Luleå, who encouraged me to apply to the doctoral programme and gave me support.

The former and current heads of the Public Dental Health Service in the County of Norrbotten **Klas Tunbrå, Jonas Thörnqvist and Tomas Josefsson** for giving me the opportunity to study for a doctoral degree during my employment as a dentist.

The Research and Innovation Unit at the County of Norrbotten for all support during my studies: **Karin Jones, Ann-Sofie Forslund, Annsofie Nilsson, Birgitta Nordström**, and their colleges.

Professor Mats Eliasson and Dr Johan Niklasson for important advice.

Magdalena Persson, economist, for all help during my doctoral education.

The County of Norrbotten, the National Society for Research on Ageing (RÅF), Karolinska Institutet and Swedish Orofacial Association (SOM) for research funding.

All my **colleges and co-workers at Tandvårdens Kompetenscentrum, TKC**, in Luleå for your tolerance with me as an “absent boss” from time to time, all the personnel at Folktandvården Porsudden for your support, and the personnel at all dental clinics in the County of Norrbotten, who enabled my data collection.

My dear research and PhD brother **Göran Friman** who always knew the right thing to say and contributed with energy and friendship.

All **participants, their relatives and the personnel** at nursing homes and group housings in my studies who gave their time and engagement in this project.

Kerstin Lantto, head of Folktandvården Porsudden and my dear friend, who always believed in me and always supported me in all possible ways. Thank you for everything!

Lena Lahti, photographer, my dear friend and cousin who contributed with the beautiful cover picture for the thesis.

All friends who in solidarity wait for me to return to a normal social life.

My beloved daughters, **Agnes and Cornelia**, who enlightened every day.

At last, my wonderful husband and best friend **Lars**, who has been my greatest support in everything. Thank you for your patience, your help and your love. You’re my man!

10 REFERENCES

- (1) Davis DM, Fiske J, Scott B, Radford DR. The emotional effects of tooth loss in a group of partially dentate people: a quantitative study. *Eur J Prosthodont Restor Dent* 2001 Jun-1;9(2):53-57.
- (2) Davis D, Fiske J, Scott B, Radford D. Prosthetics: The emotional effects of tooth loss: a preliminary quantitative study. *Br Dent J* 2000;188(9):503-506.
- (3) Fiske J, Davis DM, Frances C, Gelbier S. The emotional effects of tooth loss in edentulous people. *Br Dent J* 1998 Jan-24;184(2):90-3;.
- (4) Palma PD, Nordenram G. The perceptions of homeless people in Stockholm concerning oral health and consequences of dental treatment: a qualitative study. *Special Care in Dentistry* 2005;25(6):289-295.
- (5) Tsakos G, Watt RG, Rouxel PL, de Oliveira C, Demakakos P. Tooth Loss Associated with Physical and Cognitive Decline in Older Adults. *J Am Geriatr Soc* 2014 Dec-19.
- (6) Trulsson U, Engstrand P, Berggren U, Nannmark U, Brånemark P. Edentulousness and oral rehabilitation: experiences from the patients' perspective. *Eur J Oral Sci* 2002;110(6):417-424.
- (7) Ando A, Tanno K, Ohsawa M, Onoda T, Sakata K, Tanaka F, et al. Associations of number of teeth with risks for all-cause mortality and cause-specific mortality in middle-aged and elderly men in the northern part of Japan: the Iwate-KENCO study. *Community Dent Oral Epidemiol* 2014 Jan-29.
- (8) Gerritsen AE, Allen PF, Witter DJ, Bronkhorst EM, Creugers NH. Tooth loss and oral health-related quality of life: a systematic review and meta-analysis. *Health and Quality of Life Outcomes* 2010 Nov-5;8.
- (9) Mack F, Schwahn C, Feine JS, Mundt T, Bernhardt O, John U, et al. The impact of tooth loss on general health related to quality of life among elderly Pomeranians: results from the study of health in Pomerania (SHIP-O). *Int J Prosthodont* 2005 Sep-1;18(5):414-9.
- (10) Österberg T, Carlsson GE, Sundh V, Mellström D. Number of teeth—a predictor of mortality in 70 year old subjects. *Community Dent Oral Epidemiol* 2008;36(3):258-268.
- (11) Polzer I, Schwahn C, Völzke H, Mundt T, Biffar R. The association of tooth loss with all-cause and circulatory mortality. Is there a benefit of replaced teeth? A systematic review and meta-analysis. *Clin Oral Investig* 2012;16(2):333-351.
- (12) Vedin O, Hagstrom E, Budaj A, Denchev S, Harrington RA, Koenig W, et al. Tooth loss is independently associated with poor outcomes in stable coronary heart disease. *Eur J Prev Cardiol* 2015 Dec 16.

- (13) Weijenberg RA, Scherder EJ, Lobbezoo F. Mastication for the mind-the relationship between mastication and cognition in ageing and dementia. *Neuroscience & Biobehavioral Reviews* 2011 Jan-1;35(3):483-497.
- (14) Mann CJ. Observational research methods. Research design II: cohort, cross-sectional, and case-control studies. *Emerg Med J* 2003 Jan;20(1):54-60.
- (15) Edman K, Öhrn K, Holmlund A, Nordström B, Hedin M, Hellberg D. Comparison of oral status in an adult population 35–75 year of age in the county of Dalarna, Sweden in 1983 and 2008. *Swed Dent J* 2012;36(2):61-70.
- (16) Kassebaum NJ, Bernabe E, Dahiya M, Bhandari B, Murray CJ, Marcenes W. Global Burden of Severe Tooth Loss: A Systematic Review and Meta-analysis. *J Dent Res* 2014 Jul;93(7 Suppl):20S-28S.
- (17) Lundegren N, Axtelius B, Akerman S. Oral health in the adult population of Skåne, Sweden: a clinical study. *Acta Odontol Scand* 2012 Dec-1;70(6):511-519.
- (18) Norderyd O, Koch G, Papias A, Köhler AA, Helkimo AN, Brahm CO, et al. Oral health of individuals aged 3-80 years in Jönköping, Sweden during 40 years (1973-2013). II. Review of clinical and radiographic findings. *Swed Dent J* 2015 Jan-1;39(2):69-86.
- (19) Norrbottens läns landsting. EPI-norr 1991 - 2001 - 2011 : en undersökning av vuxna norrbottningars munhälsa, deras upplevelser av och attityder till tandvården samt en bedömning av vårdbehovet . 2013;3. ISBN 978-91-637-4149-4.
- (20) Stock C, Jürges H, Shen J, Bozorgmehr K, Listl S. A comparison of tooth retention and replacement across 15 countries in the over-50s. *Community Dentistry & Oral Epidemiology* 2016 06;44(3):223.
- (21) Fitzpatrick J. Oral health care needs of dependent older people: responsibilities of nurses and care staff. *J Adv Nurs* 2000;32(6):1325-1332.
- (22) Gabre P, Martinsson T, Gahnberg L. Incidence of, and reasons for, tooth mortality among mentally retarded adults during a 10-year period. *Acta Odontologica* 1999;57(1):55-61.
- (23) Heaton LJ, Mancl LA, Grembowski D, Armfield JM, Milgrom P. Unmet dental need in community-dwelling adults with mental illness: results from the 2007 Medical Expenditure Panel Survey. *Journal of the American Dental Association : JADA* 2013 Mar-1;144(3):e16-23.
- (24) Janardhanan T, Cohen CI, Kim S, Rizvi BF. Dental care and associated factors among older adults with schizophrenia. *J Am Dent Assoc* 2011;142(1):57-65.

- (25) Kisely S, Quek LH, Pais J, Lalloo R, Johnson NW, Lawrence D. Advanced dental disease in people with severe mental illness: systematic review and meta-analysis. *The British Journal of Psychiatry* 2011 Sep-1;199(3):187-93.
- (26) Morgan JP, Minihan PM, Stark PC, Finkelman MD, Yantsides KE, Park A, et al. The oral health status of 4,732 adults with intellectual and developmental disabilities. *J Am Dent Assoc* 2012;143(8):838-846.
- (27) Peltola P, Vehkalahti MM, Wuolijoki-Saaristo K. Oral health and treatment needs of the long-term hospitalised elderly. *Gerodontology* 2004;21(2):93-99.
- (28) Holmén A, Strömberg E, Hagman-Gustafsson M, Wårdh I, Gabre P. Oral status in home-dwelling elderly dependent on moderate or substantial supportive care for daily living: prevalence of edentulous subjects, caries and periodontal disease. *Gerodontology* 2012;29(2):e503-e511.
- (29) Samson H, Strand GV, Haugejorden O. Change in oral health status among the institutionalized Norwegian elderly over a period of 16 years. *Acta Odontol Scand* 2008;66(6):368-373.
- (30) Saarela RK, Soini H, Hiltunen K, Muurinen S, Suominen M, Pitkala K. Dentition status, malnutrition and mortality among older service housing residents. *J Nutr Health Aging* 2014 Jan;18(1):34-38.
- (31) Axelsson S, Davidsson T, Gynther G, Helgesson G, Hultin M, Håkansson K, et al. Tandförluster: En systematisk litteraturöversikt. 2010.
- (32) Steinmassl PA, Steinmassl O, Kraus G, Dumfahrt H, Grunert I. Shortcomings of prosthodontic rehabilitation of patients living in long-term care facilities. *J Oral Rehabil* 2016 Apr-1;43(4):286-90.
- (33) Müller F, Hasse-Sander I, Hupfauf L. Studies on adaptation to complete dentures. Part I: Oral and manual motor ability. *J Oral Rehabil* 1995 Jul-1;22(7):501-7.
- (34) Schimmel M, Müller F, Suter V, Buser D. Implants for elderly patients. *Periodontol* 2000 2017 Feb-1;73(1):228-240.
- (35) Müller F. Interventions for edentate elders-what is the evidence? *Gerodontology* 2014 Feb-1;31:44-51.
- (36) Luraschi J, Korgaonkar MS, Whittle T, Schimmel M, Müller F, Klineberg I. Neuroplasticity in the adaptation to prosthodontic treatment. *J Orofac Pain* 2013 Jan-1;27(3):206-16.
- (37) The Swedish National Dental Service Act (1985:125). *Svensk författningssamling* 1985:125.

- (38) The National Board of Health and Welfare. Särskild tandvårdsförfordning. :SFS 1998:1338.
- (39) Locker D, Allen F. What do measures of 'oral health-related quality of life' measure? *Community Dent Oral Epidemiol* 2007 Dec-1;35(6):401-11.
- (40) Nickel PJ. Vulnerable populations in research: the case of the seriously ill. *Theor Med Bioeth* 2006;27(3):245-264.
- (41) Norberg A. Performing research with people who are not capable of giving their informed consent to research is sometimes justified. *Nursing Ethics* 2004;11(3):225-226.
- (42) The Swedish Social Service (2001:453). *Svensk författningssamling* 2001:453 .
- (43) De Marchi RJ, Hugo FN, Hilgert JB, Padilha DM. Number of teeth and its association with central obesity in older Southern Brazilians. *Community Dent Health* 2012 Mar-1;29(1):85-89.
- (44) Kim E, Lee SG, Choi Y, Won K, Moon JS, Merchant AT, et al. Association between diabetes-related factors and clinical periodontal parameters in type-2 diabetes mellitus. *BMC oral health* 2013;13(1):64.
- (45) Lee MS, Huang YC, Wahlqvist ML. Chewing ability in conjunction with food intake and energy status in later life affects survival in Taiwanese with the metabolic syndrome. *J Am Geriatr Soc* 2010 Jun-1;58(6):1072-1080.
- (46) Matsuyama Y, Aida J, Watt RG, Tsuboya T, Koyama S, Sato Y, et al. Dental Status and Compression of Life Expectancy with Disability. *J Dent Res* 2017 Aug-1;96(9):1006-1013.
- (47) Naorungroj S, Slade GD, Beck JD, Mosley TH, Gottesman RF, Alonso A, et al. Cognitive decline and oral health in middle-aged adults in the ARIC study. *J Dent Res* 2013 Sep-1;92(9):795-801.
- (48) Nilsson H, Berglund J, Renvert S. Tooth loss and cognitive functions among older adults. *Acta Odontol Scand* 2014 Nov-1;72(8):639-644.
- (49) Noble JM, Scarmeas N, Papapanou PN. Poor Oral Health as a Chronic, Potentially Modifiable Dementia Risk Factor: Review of the Literature. *Current neurology and neuroscience reports* 2013;13(10):1-8.
- (50) Rydén L, Buhlin K, Ekstrand E, de Faire U, Gustafsson A, Holmer J, et al. Periodontitis Increases the Risk of a First Myocardial Infarction: A Report From the PAROKRANK Study. *Circulation* 2016 Feb-9;133(6):576-83.
- (51) Schwahn C, Polzer I, Haring R, Dörr M, Wallaschofski H, Kocher T, et al. Missing, unreplaced teeth and risk of all-cause and cardiovascular mortality. *Int J Cardiol* 2013 Aug-20;167(4):1430-1437.

- (52) Sjögren P, Nilsson E, Forsell M, Johansson O, Hoogstraate J. A systematic review of the preventive effect of oral hygiene on pneumonia and respiratory tract infection in elderly people in hospitals and nursing homes: effect estimates and methodological quality of randomized controlled trials. *J Am Geriatr Soc* 2008 Nov-1;56(11):2124-2130.
- (53) Trulsson M, Bilt A, Carlsson G, Gotfredsen K, Larsson P, Müller F, et al. From brain to bridge: masticatory function and dental implants. *J Oral Rehabil* 2012;39(11):858-877.
- (54) Stein PS, Desrosiers M, Donegan SJ, Yepes JF, Kryscio RJ. Tooth loss, dementia and neuropathology in the Nun study. *J Am Dent Assoc* 2007;138(10):1314-1322.
- (55) Kubo K, Ichihashi Y, Kurata C, Iinuma M, Mori D, Katayama T, et al. Masticatory function and cognitive function. *Okajimas Folia Anat Jpn* 2010;87(3):135-140.
- (56) Nakanishi N, Fukuda H, Takatorige T, Tatara K. Relationship between self-assessed masticatory disability and 9-year mortality in a cohort of community-residing elderly people. *J Am Geriatr Soc* 2005 Jan-1;53(1):54-58.
- (57) Boorse C. Health as a theoretical concept. *Philosophy of science* 1977;44(4):542-573.
- (58) Scadding JG. Health and disease: what can medicine do for philosophy? *J Med Ethics* 1988 Sep;14(3):118-124.
- (59) World Health Organization. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no.2, p. 100) and entered into force on 7 Apr 1948. 1948.
- (60) Locker D. Measuring oral health: a conceptual framework. *Community Dent Health* 1988 Mar;5(1):3-18.
- (61) Glick M, Williams DM, Kleinman DV, Vujicic M, Watt RG, Weyant RJ. A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. *J Public Health Dent* 2017;77(1):3-5.
- (62) FDI World Dental Federation. Available at: <http://www.fdiworldddental.org/oral-health/fdis-definition-of-oral-health>.
- (63) Bergdahl M, Habib R, Bergdahl J, Nyberg L, NILSSON L. Natural teeth and cognitive function in humans. *Scand J Psychol* 2007;48(6):557-565.
- (64) Elsig F, Schimmel M, Duvernay E, Giannelli SV, Graf CE, Carlier S, et al. Tooth loss, chewing efficiency and cognitive impairment in geriatric patients. *Gerodontology* 2013.
- (65) Lexomboon D, Trulsson M, Wårdh I, Parker MG. Chewing ability and tooth loss: association with cognitive impairment in an elderly population study. *J Am Geriatr Soc* 2012;60(10):1951-1956.

- (66) Christensen LB, Hede B, Nielsen E. A cross-sectional study of oral health and oral health-related quality of life among frail elderly persons on admission to a special oral health care programme in Copenhagen City, Denmark. *Gerodontology* 2012;29(2):392-393-400.
- (67) Hopcraft MS, Morgan MV, Satur JG, Wright F. Edentulism and dental caries in Victorian nursing homes. *Gerodontology* 2012;29(2):e512-e519.
- (68) Niesten D, Witter D, Bronkhorst E, Creugers N. Oral health-related quality of life and associated factors in a care-dependent and a care-independent older population. *Journal of Dentistry* 2016 December 2016;55(Supplement C):33-39.
- (69) Santucci D, Attard N. The Oral Health-Related Quality of Life in State Institutionalized Older Adults in Malta. *Int J Prosthodont* 2015 Jul-1;28(4):402-11.
- (70) Müller F, Shimazaki Y, Kahabuka F, Schimmel M. Oral health for an ageing population: the importance of a natural dentition in older adults. *Int Dent J* 2017 09;67 Suppl 2:7-13.
- (71) Thalji G, McGraw K, Cooper LF. Maxillary Complete Denture Outcomes: A Systematic Review of Patient-Based Outcomes. *Int J Oral Maxillofac Implants* 2016;31.
- (72) Jenei Á, Sándor J, Hegedűs C, Bágyi K, Nagy L, Kiss C, et al. Oral health-related quality of life after prosthetic rehabilitation: a longitudinal study with the OHIP questionnaire. *Health and Quality of Life Outcomes* 2015 Jul-10;13.
- (73) Thomason JM, Heydecke G, Feine JS, Ellis JS. How do patients perceive the benefit of reconstructive dentistry with regard to oral health-related quality of life and patient satisfaction? A systematic review. *Clin Oral Implants Res* 2007 Jun-1;18:168-88.
- (74) Heydecke G, Locker D, Awad MA, Lund JP, Feine JS. Oral and general health-related quality of life with conventional and implant dentures. *Community Dent Oral Epidemiol* 2003;31(3):161-168.
- (75) Allen PF, McMillan AS. A longitudinal study of quality of life outcomes in older adults requesting implant prostheses and complete removable dentures. *Clinical Oral Implant Research* 2003;14:173-174-179.
- (76) Wilson IB, Cleary PD. Linking clinical variables with health-related quality of life: a conceptual model of patient outcomes. *JAMA* 1995;273(1):59-65.
- (77) Guyatt GH, Feeny DH, Patrick DL. Measuring health-related quality of life. *Ann Intern Med* 1993;118(8):622-629.
- (78) Hays RD, Morales LS. The RAND-36 measure of health-related quality of life. *Ann Med* 2001;33(5):350-357.
- (79) Larsson P, John MT, Hakeberg M, Nilner K, List T. General population norms of the Swedish short forms of Oral Health Impact Profile. *J Oral Rehabil* 2014 Jan-22.

- (80) Hägglin C, Berggren U, Lundgren J. A Swedish version of the GOHAI index. Psychometric properties and validation. *Swed Dent J* 2005 Jan-1;29(3):113-24.
- (81) Johnson R, Waterfield J. Making words count: the value of qualitative research. *Physiotherapy Research International* 2004;9(3):121-131.
- (82) Britten N. Qualitative interviews in medical research. *BMJ* 1995 Jul 22;311(6999):251-253.
- (83) Turner III DW. Qualitative Interview Design: A Practical Guide for Novice Investigators. *Qualitative report* 2010 May-1;15(3):754-760.
- (84) Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today* 2004 February 2004;24(2):105-112.
- (85) World Health Organization. International Classification of Functioning, Disability and Health: ICF. : World Health Organization; 2001.
- (86) Swedish Code of Statutes SFS 1993:387. The Swedish Act (1993:387) concerning Support and Service for Persons with Certain Functional Impairments (LSS).
- (87) The Swedish National Dental Service Act (1985:125). *Svensk författningssamling* 1985:125.
- (88) Curry LA. Mixed methods in biomedical and health services research.
- (89) Chen HY, Boore JR. Using a synthesised technique for grounded theory in nursing research. *J Clin Nurs* 2009 Aug-1;18(16):2251-2260.
- (90) Corbin J, Strauss A. Basics of qualitative research: Grounded theory procedures and techniques. *Basics of qualitative research: Grounded Theory procedures and techniques* 1990:41.
- (91) Glaser BG, Strauss AL. The discovery of grounded theory: Strategies for qualitative research. Transaction Books; 2009.
- (92) Hallberg LR. The“core category” of grounded theory: Making constant comparisons. *International Journal of Qualitative Studies on Health and Well-being* 2006;1:141-142-148.
- (93) Charmaz K. Grounded Theory in the 21 century: Applications for Advancing Social Justice Studies. In: Denzin NK, Lincoln YS, editors. *The Sage Handbook of Qualitative Research*. 3rd ed.: Sage Publications; 2005. p. 507-508-535.
- (94) Närlid M. Norrbotten i täten med hjälp av VAS. *Läkartidningen* 2008;volym 105(21):1554-1555-1557.

- (95) <https://lakemedelsverket.se/malgrupp/Halso-sjukvard/Medicinteknisk-sakerhetsinformation/fran-tillverkare/FSN2014/Medicinsk-programvara-VAS-Vardadministrativt-system-Norrbottnens-lans-landsting/>.
- (96) Strauss A, Corbin J. Basics of qualitative research techniques. Sage publications; 1998.
- (97) Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. *J Am Geriatr Soc* 1975 Oct;23(10):433-441.
- (98) Erkinjuntti T, Sulkava R, Wikström J, Autio L. Short Portable Mental Status Questionnaire as a screening test for dementia and delirium among the elderly. *J Am Geriatr Soc* 1987;35(5):412-416.
- (99) Hays RD, Sherbourne CD, Mazel RM. The RAND 36-Item Health Survey 1.0. *Health Econ* 1993 Oct-1;2(3):217-27.
- (100) <http://rcso.se/patientmedverkan/prom/generiska-instrument/rand-36sf-36/>.
- (101) VanderZee KI, Sanderman R, Heyink J. A comparison of two multidimensional measures of health status: the Nottingham Health Profile and the RAND 36-Item Health Survey 1.0. *Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation* 1996 Feb-1;5(1):165-74.
- (102) VanderZee KI, Sanderman R, Heyink JW, de Haes H. Psychometric qualities of the RAND 36-Item Health Survey 1.0: a multidimensional measure of general health status. *Int J Behav Med* 1996;3(2):104.
- (103) Stewart AL, Hays RD, Ware JE Jr. The MOS short-form general health survey. Reliability and validity in a patient population. *Med Care* 1988 Jul-1;26(7):724-35.
- (104) Atchison KA, Dolan TA. Development of the Geriatric Oral Health Assessment Index. *J Dent Educ* 1990 Nov;54(11):680-687.
- (105) Locker D, Matear D, Stephens M, Lawrence H, Payne B. Comparison of the GOHAI and OHIP-14 as measures of the oral health-related quality of life of the elderly. *Community Dent Oral Epidemiol* 2001;29(5):373-381.
- (106) Slade GD. Derivation and validation of a short-form oral health impact profile. *Community Dent Oral Epidemiol* 1997;25(4):284-290.
- (107) Hägglin C, Berggren U, Hakeberg M, Edvardsson A, Eriksson M. Evaluation of a Swedish version of the OHIP-14 among patients in general and specialist dental care. *Swed Dent J* 2007 Jan-1;31(2):91-101.
- (108) Larsson P, List T, Lundström I, Marcusson A, Ohrbach R. Reliability and validity of a Swedish version of the Oral Health Impact Profile (OHIP-S). *Acta Odontol Scand* 2004 Jun-1;62(3):147-152.

- (109) Eichner K. [Renewed examination of the group classification of partially edentulous arches by Eichner and application advices for studies on morbidity statistics]. *Stomatol DDR* 1990 Aug-1;40(8):321-5.
- (110) Ikebe K, Matsuda K, Murai S, Maeda Y, Nokubi T. Validation of the Eichner index in relation to occlusal force and masticatory performance. *Int J Prosthodont* 2010 Nov-1;23(6):521-524.
- (111) Vigild M. Benefit related assessment of treatment need among institutionalised elderly people. *Gerodontology* 1993;10(1):10-15.
- (112) SPSS. <http://www.spss.com.hk/software/statistics/>; .
- (113) Agresti A, Caffo B. Simple and Effective Confidence Intervals for Proportions and Differences of Proportions Result from Adding Two Successes and Two Failures. *The American Statistician* 2000;54(4):280-288.
- (114) Baelum V, van Palenstein Helderma W, Hugoson A, Yee R, Fejerskov O. A global perspective on changes in the burden of caries and periodontitis: implications for dentistry. *J Oral Rehabil* 2007 Dec-1;34(12):872-906; discussion 940.
- (115) Hassel AJ, Koke U, Schmitter M, Rammelsberg P. Factors associated with oral health-related quality of life in institutionalized elderly. *Acta Odontol Scand* 2006 Feb-1;64(1):9-15.
- (116) Zenthöfer A, Rammelsberg P, Cabrera T, Schröder J, Hassel AJ. Determinants of oral health-related quality of life of the institutionalized elderly. *Psychogeriatrics* 2014;14(4):247-254.
- (117) Ribeiro GR, Costa JL, Ambrosano GM, Garcia RC. Oral health of the elderly with Alzheimer's disease. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology* 2012 Sep-1;114(3):338-43.
- (118) Janssens B, Vanobbergen J, Petrovic M, Jacquet W, Schols J, De Visschere L. The oral health condition and treatment needs of nursing home residents in Flanders (Belgium). *Community Dent Health* 2017;34(3):143-151.
- (119) Ekfeldt A, Zellmer M, Carlsson GE. Treatment with implant-supported fixed dental prostheses in patients with congenital and acquired neurologic disabilities: a prospective study. *Int J Prosthodont* 2013 Nov-1;26(6):517-524.
- (120) López-Jiménez J, Romero-Domínguez A, Giménez-Prats MJ. Implants in handicapped patients. *Medicina oral* 2003 Aug-1;8(4):288-93.
- (121) Altenhoevel A, Norman K, Smoliner C, Peroz I. The impact of self-perceived masticatory function on nutrition and gastrointestinal complaints in the elderly. *J Nutr Health Aging* 2012 Feb-1;16(2):175-178.

- (122) Lamy M, Mojon P, Kalykakis G, Legrand R, Butz-Jorgensen E. Oral status and nutrition in the institutionalized elderly. *J Dent* 1999 Aug-1;27(6):443-448.
- (123) Samnieng P, Ueno M, Shinada K, Zaitso T, Wright FA, Kawaguchi Y. Oral health status and chewing ability is related to mini-nutritional assessment results in an older adult population in Thailand. *Journal of Nutrition in Gerontology and Geriatrics* 2011 Jan-1;30(3):291-304.
- (124) Awad MA, Morais JA, Wollin S, Khalil A, Gray-Donald K, Feine JS. Implant overdentures and nutrition: a randomized controlled trial. *J Dent Res* 2012 Jan-1;91(1):39-46.
- (125) Iwasaki M, Taylor GW, Manz MC, Yoshihara A, Sato M, Muramatsu K, et al. Oral health status: relationship to nutrient and food intake among 80-year-old Japanese adults. *Community Dent Oral Epidemiol* 2014 Oct-1;42(5):441-50.
- (126) Naka O, Anastassiadou V. Assessing oral health promotion determinants in active Greek elderly. *Gerodontology* 2012;29(2):e427-e434.
- (127) Myndigheten för vårdanalys. Tandlösa tandvårdsstöd. 2015.
- (128) Derblom C, Hagman-Gustafsson ML, Gabre P. Dental attendance patterns among older people: a retrospective review of records in public and private dental care in Sweden. *International journal of dental hygiene* 2016 Nov-20.
- (129) Grönbeck-Linden I, Hägglin C, Petersson A, Linander PO, Gahnberg L. Discontinued dental attendance among elderly people in Sweden. *Journal of International Society of Preventive and Community Dentistry* 2016 May-1;6(3):224-9.
- (130) Felton D, Cooper L, Duqum I, Minsley G, Guckes A, Haug S, et al. Evidence-Based Guidelines for the Care and Maintenance of Complete Dentures: A Publication of the American College of Prosthodontists. *Journal of Prosthodontics* 2011;20(s1).
- (131) De Souza e Silva, Maria Elisa, De Magalhães CS, Ferreira E, Ferreira E. Complete removable prostheses: from expectation to (dis) satisfaction. *Gerodontology* 2009;26(2):143-149.
- (132) Smith PA, Entwistle VA, Nuttall N. Patients' experiences with partial dentures: a qualitative study. *Gerodontology* 2005;22(4):187-192.
- (133) Ellis JS, Levine A, Bedos C, Mojon P, Rosberger Z, Feine J, et al. Refusal of implant supported mandibular overdentures by elderly patients. *Gerodontology* 2011 Mar-1;28(1):62-68.
- (134) Müller F, Wahl G, Fuhr K. Age-related satisfaction with complete dentures, desire for improvement and attitudes to implant treatment. *Gerodontology* 1994 Jul-1;11(1):7-12.

- (135) Müller F, Duvernay E, Loup A, Vazquez L, Herrmann FR, Schimmel M. Implant-supported mandibular overdentures in very old adults: a randomized controlled trial. *J Dent Res* 2013 Dec-1;92(12 Suppl):154S-60S.
- (136) Maniewicz S, Buser R, Duvernay E, Vazquez L, Loup A, Perneger TV, et al. Short Dental Implants Retaining Two-Implant Mandibular Overdentures in Very Old, Dependent Patients: Radiologic and Clinical Observation Up to 5 Years. *Int J Oral Maxillofac Implants* 2017 Mar-1;32(2):415-422.
- (137) Olerud E, Hagman-Gustafsson M, Gabre P. Oral status, oral hygiene, and patient satisfaction in the elderly with dental implants dependent on substantial needs of care for daily living. *Special Care in Dentistry* 2012;32(2):49-54.
- (138) Narby B, Kronström M, Söderfeldt B, Palmqvist S. Prosthodontics and the Patient: What Is Oral Rehabilitation Need? Conceptual Analysis of Need and Demand for Prosthodontic Treatment. Part 1: A Conceptual Analysis. *The International journal of prosthodontics* 2005;18:75-74-79.
- (139) Narby B, Kronström M, Söderfeldt B, Palmqvist S. Prosthodontics and the patient. Part 2: Need becoming demand, demand becoming utilization. *Int J Prosthodont* 2007 Mar-1;20(2):183-189.
- (140) Locker D, Gibson B. Discrepancies between self-ratings of and satisfaction with oral health in two older adult populations. *Community Dent Oral Epidemiol* 2005 Aug-1;33(4):280-8.
- (141) Slade GD, Sanders AE. The paradox of better subjective oral health in older age. *J Dent Res* 2011 Nov-1;90(11):1279-85.
- (142) Albrecht GL, Devlieger PJ. The disability paradox: high quality of life against all odds. *Soc Sci Med* 1999 Apr-1;48(8):977-88.
- (143) Schwartz CE, Andresen EM, Nosek MA, Krahn GL, RRTC Expert Panel on Health Status Measurement. Response shift theory: important implications for measuring quality of life in people with disability. *Arch Phys Med Rehabil* 2007;88(4):529-536.
- (144) Black N. Why we need observational studies to evaluate the effectiveness of health care. *BMJ* 1996 May 11;312(7040):1215-1218.
- (145) O’Cathain A, Goode J, Drabble SJ, Thomas KJ, Rudolph A, Hewison J. Getting added value from using qualitative research with randomized controlled trials: a qualitative interview study. *Trials* 2014;15(1):215.